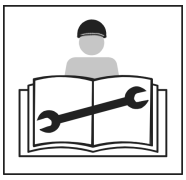
Service Manual

Models
G5-19A
&
G6-23A

P/N - 31200193

Revised
November 17, 2006



EFFECTIVITY PAGE

March 24, 2006 - A - Original Issue Of Manual

November 17, 2006 - B - Added Controller procedure in Section 9.

EFFECTIVITY PAGE

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Section 1
Safety Practices

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1.1 INTRODUCTION

This service manual provides general directions for accomplishing service and repair procedures. Following the procedures in this manual will help assure safety and equipment reliability.

Read, understand and follow the information in this manual, and obey all locally approved safety practices, procedures, rules, codes, regulations and laws.

These instructions cannot cover all details or variations in the equipment, procedures, or processes described, nor provide directions for meeting every possible contingency during operation, maintenance, or testing. When additional information is desired consult the local JLG distributor.

Many factors contribute to unsafe conditions: carelessness, fatigue, overload, inattentiveness, unfamiliarity, even drugs and alcohol, among others. For optimal safety, encourage everyone to think, and to act, safely.

Appropriate service methods and proper repair procedures are essential for the safety of the individual doing the work, for the safety of the operator, and for the safe, reliable operation of the machine. All references to the right side, left side, front and rear are given from the operator's seat looking in a forward direction.

Supplementary information is available from JLG in the form of Service Bulletins, Service Campaigns, Service Training Schools, the JLG website, other literature, and through updates to the manual itself.

1.2 DISCLAIMER

All information in this manual is based on the latest product information available at the time of publication. JLG reserves the right to make changes and improvements to its products, and to discontinue the manufacture of any product, at its discretion at any time without public notice or obligation.

1.3 OPERATION & SAFETY MANUAL

The mechanic must not operate the machine until the Operation & Safety Manual has been read & understood, training has been accomplished and operation of the machine has been completed under the supervision of an experienced and qualified operator.

An Operation & Safety Manual is supplied with each machine and must be kept in the cab. In the event that the Operation & Safety Manual is missing, consult the local **JLG** distributor before proceeding.

1.4 DO NOT OPERATE TAGS

Place Do Not Operate Tags on the ignition key switch and the steering wheel before attempting to perform any service or maintenance. Remove key and disconnect battery leads.

1.5 SAFETY INFORMATION

To avoid possible death or injury, carefully read, understand and comply with all safety messages.

In the event of an accident, know where to obtain medical assistance and how to use a first-aid kit and fire extinguisher/fire suppression system. Keep emergency telephone numbers (fire department, ambulance, rescue squad/paramedics, police department, etc.) nearby. If working alone, check with another person routinely to help assure personal safety.

1.5.1 Safety Alert System and Signal Words

⚠ DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

1.6 SAFETY INSTRUCTIONS

Following are general safety statements to consider ***before*** performing maintenance procedures on the telehandler. Additional statements related to specific tasks and procedures are located throughout this manual and are listed prior to any work instructions to provide safety information before the potential of a hazard occurs.

For all safety messages, carefully read, understand and follow the instructions ***before*** proceeding.

1.6.1 Personal Hazards

PERSONAL SAFETY GEAR: Wear all the protective clothing and personal safety gear necessary to perform the job safely. This might include heavy gloves, safety glasses or goggles, filter mask or respirator, safety shoes or a hard hat.

LIFTING: **NEVER** lift a heavy object without the help of at least one assistant or a suitable sling and hoist.

1.6.2 Equipment Hazards

LIFTING OF EQUIPMENT: Before using any lifting equipment (chains, slings, brackets, hooks, etc.), verify that it is of the proper capacity, in good working order, and is properly attached.

NEVER stand or otherwise become positioned under a suspended load or under raised equipment. The load or equipment could fall or tip.

DO NOT use a hoist, jack or jack stands only to support equipment. Always support equipment with the proper capacity blocks or stands properly rated for the load.

HAND TOOLS: Always use the proper tool for the job; keep tools clean and in good working order, and use special service tools only as recommended.

1.6.3 General Hazards

SOLVENTS: Only use approved solvents that are known to be safe for use.

HOUSEKEEPING: Keep the work area and operator's cab clean, and remove all hazards (debris, oil, tools, etc.).

FIRST AID: Immediately clean, dress and report all injuries (cuts, abrasions, burns, etc.), no matter how minor the injury may seem. Know the location of a First Aid Kit, and know how to use it.

CLEANLINESS: Wear eye protection, and clean all components with a high-pressure or steam cleaner before attempting service.

When removing hydraulic components, plug hose ends and connections to prevent excess leakage and contamination. Place a suitable catch basin beneath the machine to capture fluid run-off.

Check and obey all Federal, State and/or Local regulations regarding waste storage, disposal and recycling.

1.6.4 Operational Hazards

ENGINE: Stop the engine before performing any service unless specifically instructed otherwise.

VENTILATION: Avoid prolonged engine operation in enclosed areas without adequate ventilation.

SOFT SURFACES AND SLOPES: **NEVER** work on a machine that is parked on a soft surface or slope. The machine must be on a hard level surface, with the wheels blocked before performing any service.

FLUID TEMPERATURE: **NEVER** work on a machine when the engine, cooling or hydraulic systems are hot. Hot components and fluids can cause severe burns. Allow systems to cool before proceeding.

FLUID PRESSURE: Before loosening any hydraulic or diesel fuel component, hose or tube, turn the engine OFF. Wear heavy, protective gloves and eye protection. **NEVER** check for leaks using any part of your body; use a piece of cardboard or wood instead. If injured, seek medical attention immediately. Diesel fluid leaking under pressure can explode. Hydraulic fluid and diesel fuel leaking under pressure can penetrate the skin, cause infection, gangrene and other serious personal injury.

Relieve all pressure before disconnecting any component, part, line or hose. Slowly loosen parts and allow release of residual pressure before removing any part or component. Before starting the engine or applying pressure, use components, parts, hoses and pipes that are in good condition, connected properly and are tightened to the proper torque. Capture fluid in an appropriate container and dispose of in accordance with prevailing environmental regulations.

RADIATOR CAP: Always wear steam-resistant, heat protective gloves when opening the radiator cap. Cover the cap with a clean, thick cloth and turn slowly to the first stop to relieve pressure.

FLUID FLAMABILTITY: **DO NOT** service the fuel or hydraulic systems near an open flame, sparks or smoking materials.

NEVER drain or store fluids in an open container. Engine fuel and hydraulic fluid are flammable and can cause a fire and/or explosion.

DO NOT mix gasoline or alcohol with diesel fuel. The mixture can cause an explosion.

PRESSURE TESTING: When conducting any test, only use test equipment that is correctly calibrated and in good condition. Use the correct equipment in the proper manner, and make changes or repairs as indicated by the test procedure to achieve the desired result.

LEAVING MACHINE: Lower the forks or attachment to the ground before leaving the machine.

TIRES: Always keep tires inflated to the proper pressure to help prevent tipover. **DO NOT** over-inflate tires.

NEVER use mismatched tire types, sizes or ply ratings. Always use matched sets according to machine specifications.

MAJOR COMPONENTS: Never alter, remove, or substitute any items such as counterweights, tires, batteries or other items that may reduce or affect the overall weight or stability of the machine.

BATTERY: DO NOT charge a frozen battery.Charging a frozen battery may cause it to explode. Allow the battery to thaw before jump-starting or connecting a battery charger.

1.7 SAFETY DECALS

Check that all safety decals are present and readable on the machine. Refer to the Operation & Safety Manual supplied with machine for information.

Section 2
General Information and Specifications

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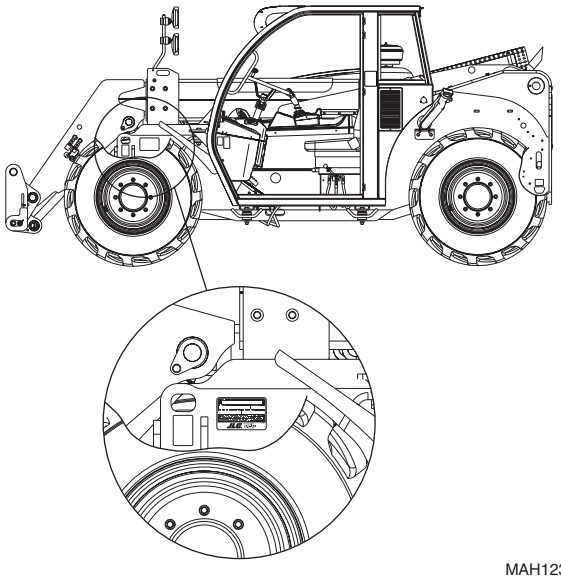
2.1 REPLACEMENT PARTS AND WARRANTY INFORMATION

Before ordering parts or initiating service inquiries, make note of the machine serial number. The machine serial number plate is located as indicated in the figure.



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IMPORTANT: *The replacement of any part on this machine with any other than a **JLG** authorized replacement part can adversely affect the performance, durability, or safety of the machine, and will void the warranty. **JLG** disclaims liability for any claims or damages, whether regarding property damage, personal injury or death arising out of the use of unauthorized replacement parts.*

A warranty registration form must be filled out by the **JLG** distributor, signed by the purchaser and returned to **JLG** when the machine is sold and/or put into use.

Registration activates the warranty period and helps to assure that warranty claims are promptly processed. To guarantee full warranty service, verify that the distributor has returned the business reply card of the warranty registration form to **JLG**.

2.2 TORQUES

2.2.1 ASTM Fastener Torque Chart (English)

SIZE	THDS. PER INCH	BOLT DIA.	TENSILE STRESS AREA	VALUES FOR ZINC PLATED / YELLOW CHROMATE FASTENERS ONLY					SAE GRADE 8 BOLTS & GRADE 8 NUTS & SOCKET HEAD CAP SCREWS					UNPLATED CAP SCREWS			
				SAE GRADE 5 BOLTS & GRADE 2 NUTS										UNBRAKO 1960 SERIES SOCKET HEAD			
				TORQUE				CLAMP LOAD	TORQUE				CLAMP LOAD	TORQUE			
				DRY OR LOCTITE 263	LUB	LOCTITE 262	LOCTITE 242 OR 271		DRY OR LOCTITE 263	LUB	LOCTITE 262	LOCTITE 242 OR 271		WITHOUT LOC-WEL PATCH	WITH LOC-WEL PATCH		
	IN	IN	SQ. IN.	LB.	IN-LB	IN-LB	IN-LB	LB.	IN-LB.	IN-LB	IN-LB	IN-LB	LB.	IN-LB	IN-LB		
4	40	0.1120	0.00604	380	8	6	—	—	540	12	9	—	—	—	—		
	48		0.00661	420	9	7	—	—	600	13	10	—	—	—	—		
6	32	0.1380	0.00909	580	16	12	—	—	820	23	17	—	—	—	—		
	40		0.01015	610	18	13	—	—	920	25	19	—	—	—	—		
8	32	0.1640	0.01400	900	30	22	—	—	1260	41	31	—	—	—	—		
	36		0.01474	940	31	23	—	—	1320	43	32	—	—	—	—		
10	24	0.1900	0.01750	1120	43	32	—	—	1580	60	45	—	—	—	—		
	32		0.02000	1285	49	36	—	—	1800	68	51	—	—	—	—		
1/4	20	0.2500	0.0318	2020	96	75	—	105	2860	144	108	—	160	3180	160	168	
	28		0.0364	2320	120	86	—	135	3280	168	120	—	185	3640	168	178	
	IN	IN	SQ. IN.	LB.	FT-LB	FT-LB	FT-LB	LB.	FT-LB	FT-LB	FT-LB	FT-LB	LB.	FT-LB	FT-LB		
5/16	18	0.3125	0.0524	3340	17	13	16	19	4720	25	18	22	30	5240	25	28	
	24		0.0580	3700	19	14	17	21	5220	25	20	25	30	5800	27	30	
3/8	16	0.3750	0.0775	4940	30	23	28	35	7000	45	35	40	50	7750	45	50	
	24		0.0878	5600	35	25	32	40	7900	50	35	45	55	8780	50	55	
7/16	14	0.4375	0.1063	6800	50	35	45	55	9550	70	55	63	80	10630	70	77	
	20		0.1187	7550	55	40	50	60	10700	80	60	70	90	11870	75	82	
1/2	13	0.5000	0.1419	9050	75	55	68	85	12750	110	80	96	120	14190	110	120	
	20		0.1599	10700	90	65	80	100	14400	120	90	108	130	15990	115	127	
9/16	12	0.5625	0.1820	11600	110	80	98	120	16400	150	110	139	165	18200	155	170	
	18		0.2030	12950	120	90	109	135	18250	170	130	154	190	20300	165	182	
5/8	11	0.6250	0.2260	14400	150	110	135	165	20350	220	170	180	240	22600	210	231	
	18		0.2560	16300	170	130	153	190	23000	240	180	204	265	25600	220	242	
3/4	10	0.7500	0.3340	21300	260	200	240	285	30100	380	280	301	420	33400	365	400	
	16		0.3730	23800	300	220	268	330	33600	420	320	336	465	37300	400	440	
7/8	9	0.8750	0.4620	29400	430	320	386	475	41600	600	460	485	660	46200	585	645	
	14		0.5090	32400	470	350	425	520	45800	660	500	534	725	50900	635	700	
1	8	1.0000	0.6060	38600	640	480	579	675	51500	900	680	687	990	60600	865	950	
	12		0.6630	42200	700	530	633	735	59700	1000	740	796	1100	66300	915	1000	
1-1/8	7	1.1250	0.7630	42300	800	600	714	840	68700	1280	960	1030	1400	76300	1240	1365	
	12		0.8560	47500	880	660	802	925	77000	1440	1080	1155	1575	85600	1380	1520	
1-1/4	7	1.2500	0.9690	53800	1120	840	1009	1175	87200	1820	1360	1453	2000	96900	1750	1925	
	12		1.0730	59600	1240	920	1118	1300	96600	2000	1500	1610	2200	107300	1880	2070	
1-3/8	6	1.3750	1.1550	64100	1460	1100	1322	1525	104000	2380	1780	1907	2625	115500	2320	2550	
	12		1.3150	73000	1680	1260	1506	1750	118100	2720	2040	2165	3000	131500	2440	2685	
1-1/2	6	1.5000	1.4050	78000	1940	1460	1755	2025	126500	3160	2360	2530	3475	140500	3040	3345	
	12		1.5800	87700	2200	1640	1974	2300	142200	3560	2660	2844	3925	158000	3270	3600	

SAE GRADE 5 SAE GRADE 8

Note: These torque values do not apply to cadmium plated fasteners.

2.2.2 ASTM Fastener Torque Chart (Metric)

				VALUES FOR ZINC PLATED / YELLOW CHROMATE FASTENERS ONLY										UNPLATED CAP SCREWS		
				SAE GRADE 5 BOLTS & GRADE 2 NUTS					SAE GRADE 8 BOLTS & GRADE 8 NUTS & SOCKET HEAD CAP SCREWS					UNBRAKO 1960 SERIES SOCKET HEAD		
					TORQUE					TORQUE					TORQUE	
SIZE	THDS. PER INCH	BOLT DIA.	TENSILE STRESS AREA	CLAMP LOAD	DRY OR LOCTITE 263	LUB	LOCTITE 262	LOCTITE 242 OR 271	CLAMP LOAD	DRY OR LOCTITE 263	LUB	LOCTITE 262	LOCTITE 242 OR 271	CLAMP LOAD	WITHOUT LOC-WEL PATCH	WITH LOC-WEL PATCH
		IN	SQ. IN.	LB.	N, m	N, m	N, m	N, m	LB.	N, m	N, m	N, m	N, m	LB.	N, m	N, m
4	40	0.1120	0.00604	380	.8	.8	—	—	540	1.4	1.0	—	—	—	—	—
	48		0.00661	420	1.0	.8	—	—	600	1.5	1.0	—	—	—	—	—
6	32	0.1380	0.00909	580	1.8	1.4	—	—	820	2.6	2.0	—	—	—	—	—
	40		0.01015	610	2.0	1.6	—	—	920	2.8	2.2	—	—	—	—	—
8	32	0.1640	0.01400	900	3.4	2.4	—	—	1260	4.6	3.4	—	—	—	—	—
	36		0.01474	940	3.4	2.6	—	—	1320	5	3.6	—	—	—	—	—
10	24	0.1900	0.01750	1120	5	3.6	—	—	1580	7	5	—	—	—	—	—
	32		0.02000	1285	6	4	—	—	1800	8	6	—	—	—	—	—
1/4	20	0.2500	0.0318	2020	11	8	—	12	2860	16	12	—	18	3180	18	19
	28		0.0364	2320	14	10	—	15	3280	19	14	—	21	3640	19	20
		IN	SQ. IN.	LB.	N, m	N, m	N, m	N, m	LB.	N, m	N, m	N, m	N, m	LB.	N, m	N, m
5/16	18	0.3125	0.0524	3340	23	18	22	26	4720	34	24	30	41	5240	34	38
	24		0.0580	3700	26	19	23	28	5220	34	27	34	41	5800	37	41
3/8	16	0.3750	0.0775	4940	41	31	38	47	7000	61	47	54	68	7750	61	68
	24		0.0878	5600	47	34	43	54	7900	68	47	61	75	8780	68	75
7/16	14	0.4375	0.1063	6800	68	47	61	75	9550	95	75	85	108	10630	95	104
	20		0.1187	7550	75	54	68	81	10700	108	81	95	122	11870	102	111
1/2	13	0.5000	0.1419	9050	102	75	92	115	12750	149	108	130	163	14190	149	163
	20		0.1599	10700	122	88	108	136	14400	163	122	146	183	15990	156	172
9/16	12	0.5625	0.1820	11600	149	108	133	163	16400	203	149	188	224	18200	210	230
	18		0.2030	12950	163	122	148	183	18250	230	176	209	258	20300	224	247
5/8	11	0.6250	0.2260	14400	203	149	183	224	20350	298	230	244	325	22600	285	313
	18		0.2560	16300	230	176	207	258	23000	325	244	277	359	25600	298	328
3/4	10	0.7500	0.3340	21300	353	271	325	386	30100	515	380	408	569	33400	495	542
	16		0.3730	23800	407	298	363	447	33600	569	434	456	630	37300	542	597
7/8	9	0.8750	0.4620	29400	583	434	523	644	41600	813	624	658	895	46200	793	874
	14		0.5090	32400	637	475	576	705	45800	895	678	724	983	50900	861	949
1	8	1.0000	0.6060	38600	868	651	785	915	51500	1220	922	931	1342	60600	1173	1288
	12		0.6630	42200	949	719	858	997	59700	1356	1003	1079	1491	66300	1241	1356
1-1/8	7	1.1250	0.7630	42300	1085	813	968	1139	68700	1735	1302	1396	1898	76300	1681	1851
	12		0.8560	47500	1193	895	1087	1254	77000	1952	1464	1566	2135	85600	1871	2061
1-1/4	7	1.2500	0.9690	53800	1518	1139	1368	1593	87200	2468	1844	1970	2712	96900	2373	2610
	12		1.0730	59600	1681	1247	1516	1763	96600	2712	2034	2183	2983	107300	2549	2807
1-3/8	6	1.3750	1.1550	64100	1979	1491	1792	2068	104000	3227	2413	2586	3559	115500	3145	3457
	12		1.3150	73000	2278	1708	2042	2373	118100	3688	2766	2935	4067	131500	3308	3640
1-1/2	6	1.5000	1.4050	78000	2630	1979	2379	2745	126500	4284	3200	3430	4711	140500	4122	4535
	12		1.5800	87700	2983	2224	2676	3118	142200	4827	3606	3856	5322	158000	4433	4881

Note: These torque values do not apply to cadmium plated fasteners.

SAE GRADE 5 SAE GRADE 8

2.2.3 Metric Fastener Torque Chart

			VALUES FOR ZINC PLATED / YELLOW CHROMATE FASTENERS ONLY									
			CLASS 8.8 METRIC BOLTS & CLASS 8 METRIC NUTS					CLASS 10.9 METRIC BOLTS & CLASS 10 METRIC NUTS				
SIZE	PITCH	TENSILE STRESS AREA	CLAMP LOAD	TORQUE				CLAMP LOAD	TORQUE			
				DRY OR LOCTITE 263	LUB	LOCTITE 262	LOCTITE 242 OR 271		DRY OR LOCTITE 263	LUB	LOCTITE 262	LOCTITE 242 OR 271
		sq. mm	KN	N, m	N, m	N, m	N, m	KN	N, m	N, m	N, m	N, m
3	.5	5.03	2.19	1.3	1.0	1.2	1.4	3.13	1.9	1.4	1.5	2.1
3.5	.6	6.78	2.95	2.1	1.6	1.9	2.3	4.22	3.0	2.2	2.4	3.3
4	.7	8.78	3.82	3.1	2.3	2.8	3.4	5.47	4.4	3.3	3.5	4.8
5	.8	14.2	6.18	6.2	4.6	5.6	6.8	8.85	8.9	6.6	7.1	9.7
6	1	20.1	8.74	11	7.9	9.4	12	12.5	15	11	12	17
7	1	28.9	12.6	18	13	16	19	18	25	19	20	28
8	1.25	36.6	15.9	25	19	23	28	22.8	37	27	29	40
10	1.5	58.0	25.2	50	38	45	55	36.1	72	54	58	79
12	1.75	84.3	36.7	88	66	79	97	52.5	126	95	101	139
14	2	115	50.0	140	105	126	154	71.6	200	150	160	220
16	2	157	68.3	219	164	197	241	97.8	313	235	250	344
18	2.5	192	83.5	301	226	271	331	119.5	430	323	344	473
20	2.5	245	106.5	426	320	383	469	152.5	610	458	488	671
22	2.5	303	132.0	581	436	523	639	189.0	832	624	665	915
24	3	353	153.5	737	553	663	811	220.0	1060	792	845	1170
27	3	459	199.5	1080	810	970	1130	286.0	1540	1160	1240	1690
30	3.5	561	244.0	1460	1100	1320	1530	349.5	2100	1570	1680	2310
33	3.5	694	302.0	1990	1490	1790	2090	432.5	2600	2140	2280	2860
36	4	817	355.0	2560	1920	2300	2690	509.0	3660	2750	2930	4020
42	4.5	1120	487.0	4090	3070	3680	4290	698.0	5860	4400	4690	6440

Note: These torque values do not apply to cadmium plated fasteners.

METRIC CLASS 8.8

METRIC CLASS 10.9

2.3 SPECIFICATIONS

2.3.1 Travel Speeds

	G5-19A	G6-23A
First Gear	6 mph (10 kmph)	4 mph (7 kmph)
Second Gear	21 mph (34 kmph)	20 mph (33 kmph)

2.3.2 Hydraulic Cylinder Performance Specifications

Note: *Machine with no load, engine at full throttle, hydraulic oil above 130° F (54° C) minimum, engine at operating temperature.*

Function	Approximate Times (sec.)	
	G5-19A	G6-23A
Boom Extend	5.66	7.09
Boom Retract	4.51	5.59
Boom Lift	5.87	8.05
Boom Lower	3.79	5.55
Attachment Tilt - UP	2.48	4.30
Attachment Tilt - DOWN	1.97	3.32

2.3.3 Electrical System

Note: *Refer to Section 9.3, "Fuses and Relays," for more information.*

Battery:	
Type, Rating	12V DC, Negative (-) Ground, Limited Maintenance, Wet Charged
Quantity	1 (100 Ah) (C_{20})
Reserve Capacity	CCA @ -.4° F: 880 EN
Group/Series	DIN 600,44
Alternator	14V, 70 Amps
Starter	12V, 3,0 KW Type EV (Gear Reduction)

2.3.4 Engine Performance Specifications

Description	G5-19A & G6-23A
Engine Make/Model	Deutz BF 4M 2012
Low Idle	925 ±50 rpm
High Idle	2370 ±50 rpm
Horsepower	100.4 BHP/ 74.9 kW @ 2200 rpm
Fuel Delivery	Fuel Injection
Air Cleaner	Dry Type, Replaceable Primary and Safety Elements

2.3.5 Tires

Description	Tire Air Pressure
405/70-24 MPT-04 **(G6-23A only)**	58.0 psi (4,0 Bar)
405/70-20 MPT-04 **(G5-19A only)**	50.7 psi (3,5 Bar)
12.5-18 MPT-02 **(G5-19A only)**	73 psi (5 Bar)

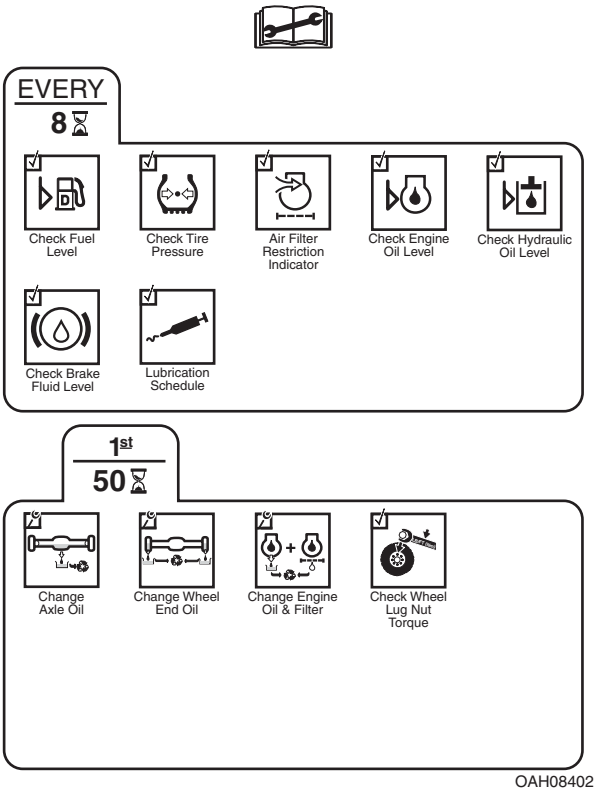
Note: *Standard wheel lug nut torque is 221 lb-ft (300 Nm).*

2.4 FLUIDS, LUBRICANTS AND CAPACITIES

Engine Crankcase Oil	
Capacity w/Filter Change	9.6 quarts (9,0 liters)
Filter Capacity	1.05 quarts (1,0 liter)
Oil Type	15W-40 CE
Fuel Filters	
Primary Fuel Filter Capacity	Approx. 0.26 quarts (1,0 liter)
Fuel Filter Capacity	0.16 quarts (0,6 liters)
Fuel Tank	
Capacity	G5-19A- 25 gallons (95 liters) G6-23A- 27 gallons (102 liters)
Type of Fuel	U.S.A. #2 Diesel
Cooling System	
System Capacity w/o Heater	10.6 quarts (10 liters)
Type of Fluid	50/50 mix of ethylene glycol & water
Axles	
Differential Housing Capacity - Front	G5-19A- 8.4 quarts (7,9 liters) G6-23A - 8.5 quarts (8 liters)
Differential Housing Capacity - Rear	G5-19A- 5.3 quarts (5 liters) G6-23A - 8.3 quarts (7,8 liters)
Wheel End Capacity	G5-19A- 0.84 quarts (0,8 liters) G6-23A - 0.7 quarts (0,65 liters)
Type of Fluid	Mobilube HDLS 80W-90
Brakes	
Master Cylinder Capacity	0.7 quarts (0,7 liters)
Type of Fluid	ATF
Hydraulic System	
System Capacity	G5-19A- 28 gallons (106 liters) G6-23A- 35 gallons (133 liters)
Reservoir Capacity to FULL Mark	G5-19A- 17 gallons (65 liters) G6-23A- 23 gallons (87 liters)
Type of Fluid	Mobilfluid® 424 Tractor Hydraulic Fluid (ISO 46)

2.5 MAINTENANCE SCHEDULES

2.5.1 8 & 1st 50 Hour Maintenance Schedule



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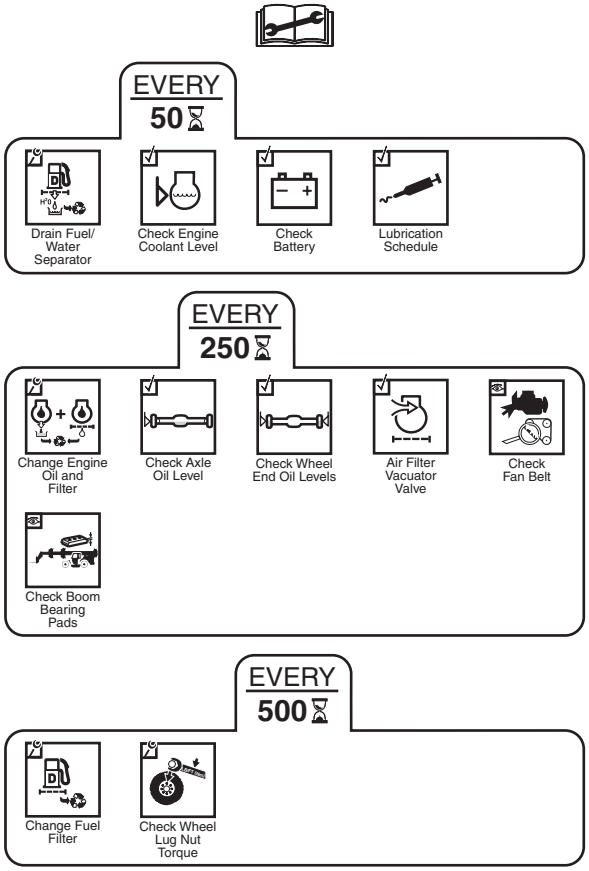
Note: *In order to gain access to the engine fuel filter, the oil filter must be removed. It is best to replace both of these filters at the same time.*

2.5.2 50, 250 & 500 Hour Maintenance Schedule



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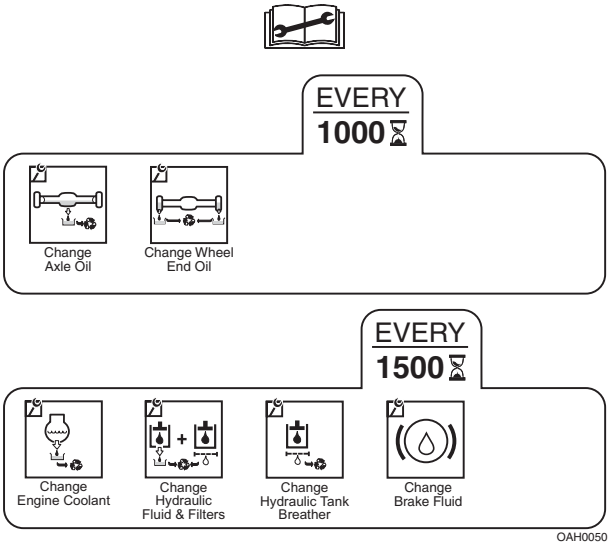
2.5.3 1000 & 1500 Hour Maintenance Schedule



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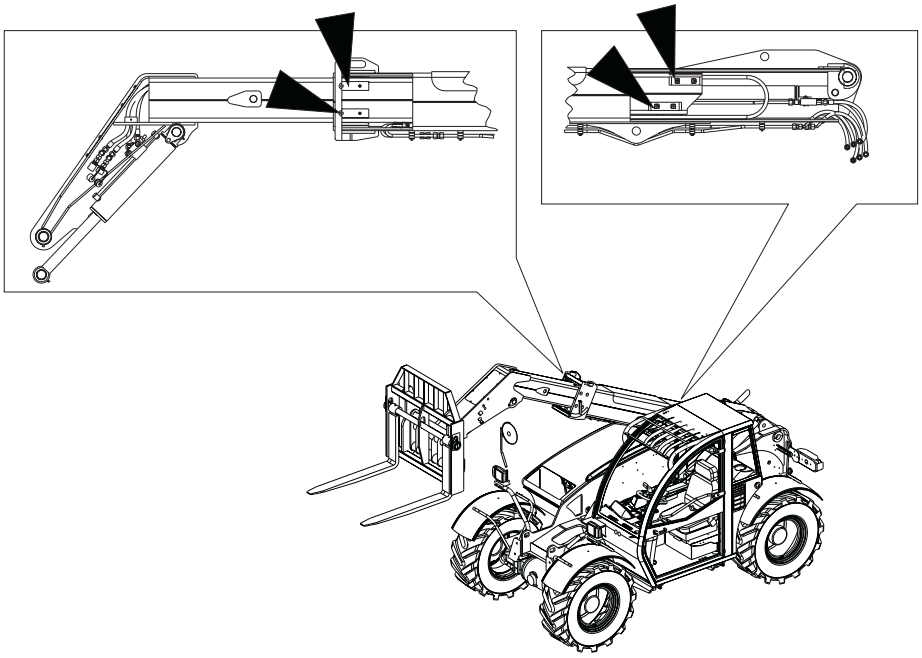
2.6 LUBRICATION SCHEDULES

2.6.1 8 Hour Lubrication Schedule

EVERY
8

MYSTIK TETRIMOLY
(NLGI 2 GC-LB)



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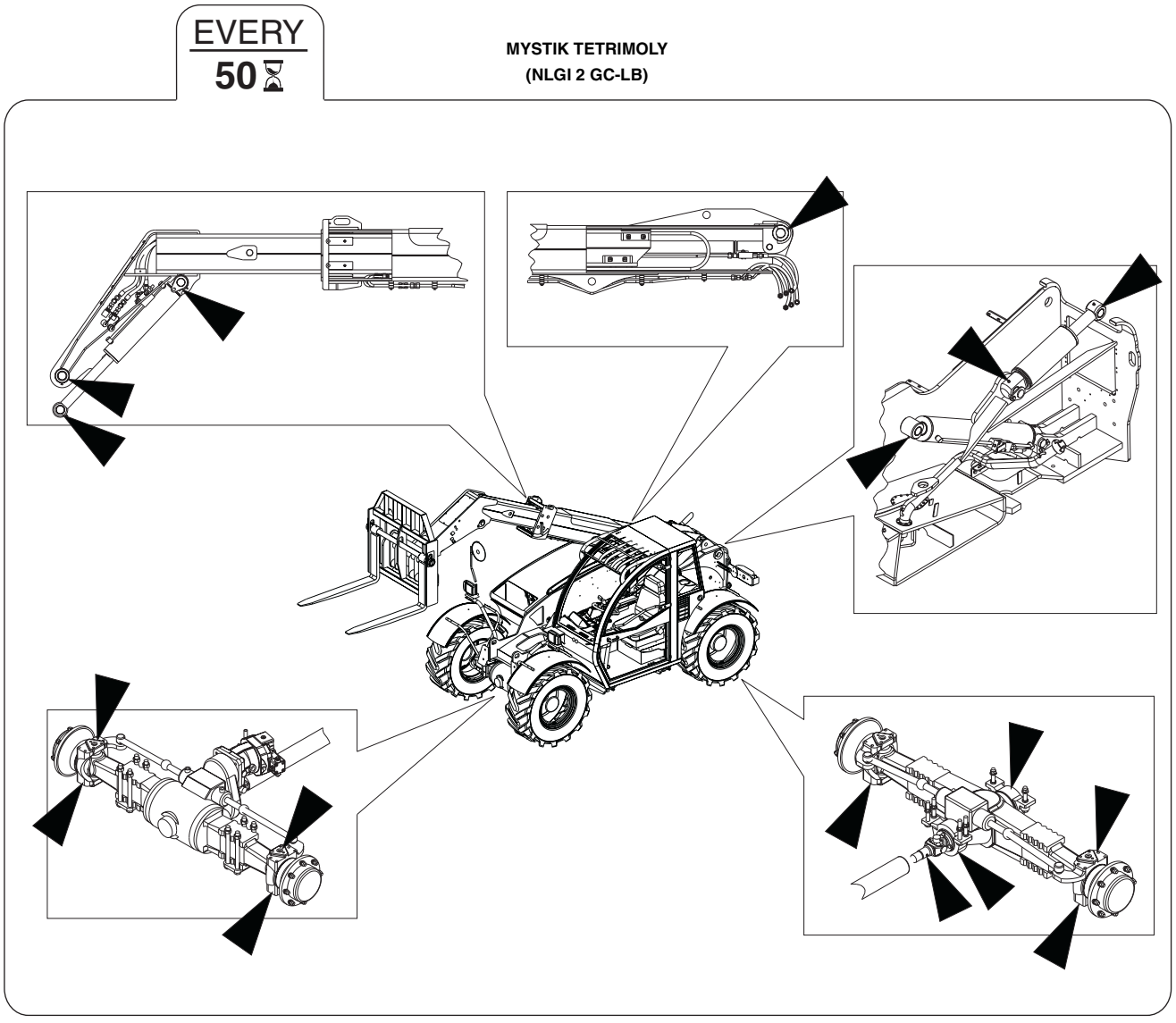
2.6.2 50 Hour Lubrication Schedule



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Section 3
Boom

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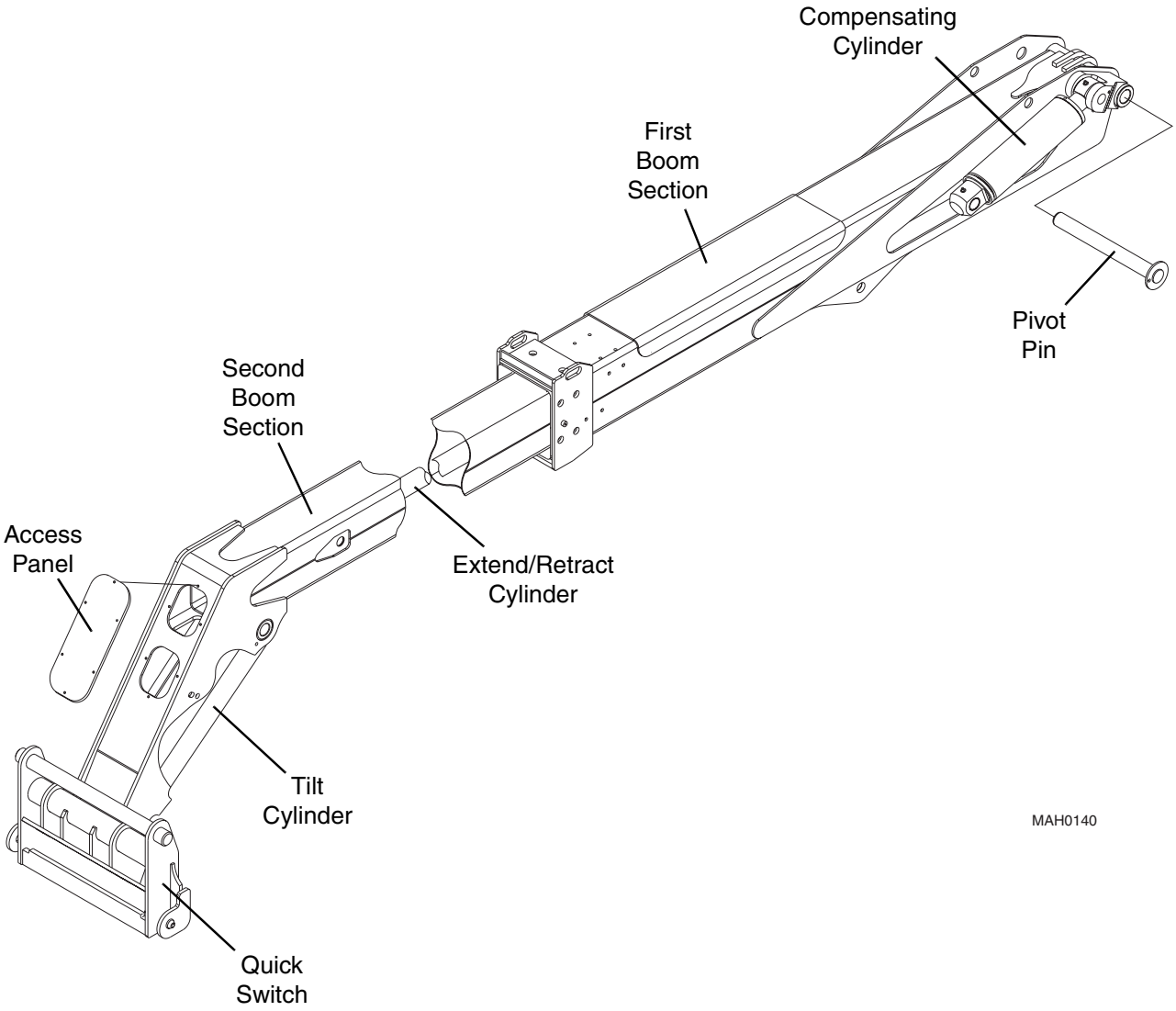
3.1 BOOM SYSTEM COMPONENT TERMINOLOGY

To understand the safety, operation and maintenance information presented in this section, it is necessary that the operator/mechanic be familiar with the names and locations of the major assemblies of the boom system. The following illustration identifies the components that are referred to throughout this section.



3.2 BOOM SYSTEM - TWO SECTION BOOM

3.2.1 Boom System Description

The boom operates via an interchange among the electrical, hydraulic and mechanical systems. Components involved include the joystick, tilt cylinder, extend/retract cylinder, lift/lower cylinder, compensating cylinder, electronic sensors, various pivots, supporting hardware and other components.

3.3 BOOM ASSEMBLY MAINTENANCE

The boom assembly consists of the first and second section booms and supporting hardware.

IMPORTANT: *Boom replacement must be completed in sequence, one boom section at a time, as described in these instructions.*

IMPORTANT: *Before removing the boom, the carriage or any other attachment must be removed from the quick attach.*

Before beginning, conduct a visual inspection of the machine and work area, and review the task about to be undertaken. Read, understand and follow these instructions.

During service of the boom, perform the following:

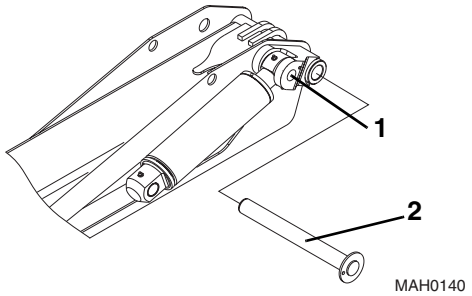
1. Check wear pads. (Refer to Section 3.4.1, “Wear Pad Inspection.”)
2. Apply grease at all lubrication points (grease fittings). (Refer to Section 2.6, “Lubrication Schedules.”)
3. Check for proper operation by operating all boom functions through their full ranges of motion several times.

3.3.1 Boom Removal

1. Remove any attachment from the quick switch assembly.
2. Be sure there is enough room in front of the machine to allow the boom sections to be removed. Park the machine on a hard, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
3. Place an Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
4. Remove the battery negative (-) cable from the battery negative (-) terminal.
5. Open the engine cover. Allow the system fluids to cool.
6. Remove the quick switch assembly. Refer to Section 3.5.4, “Quick Switch Removal.”
7. Support the front of the boom by placing a sling behind the boom head. Support the lift/lower cylinder and remove the lock bolt and then the rod end pin. Lower the lift/lower cylinder onto the frame rails.
8. Label and disconnect the tilt and auxiliary hydraulic hoses attached to the machine at the rear of the boom. Plug and cap the hose ends to prevent dirt and debris from entering the hydraulic system.
9. Label and disconnect the extend/retract hydraulic hoses at the extend/retract cylinder.

Note: *Tag or identify each hose to the corresponding fitting it was removed from.*

10. Remove the lock bolt and pin (**1**) from the rod end of the compensating cylinder on the first boom section. Rest the cylinder on the machine frame.



11. Lower the boom to a level position and place a suitable support under the rear of the boom. Reposition the slings to each end of the boom.
12. Remove the lock bolt and pivot pin (**2**) from rear of first boom section.
13. Lift the complete boom off machine and set on level ground or supports being careful not to damage the tubes on the bottom of the boom.

3.3.2 Second Section Boom Removal

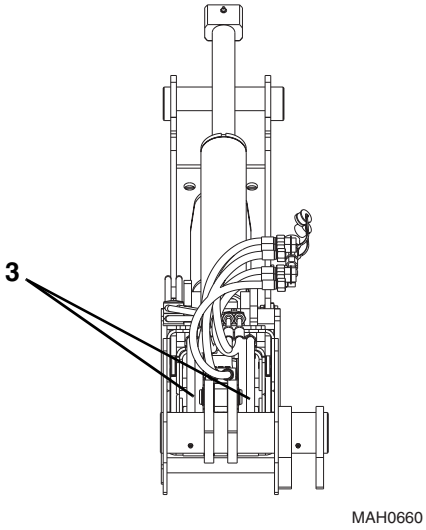
1. Set the complete boom on level ground and by repositioning the slings, turn boom over on to the top side. Set the complete boom on suitable stands to begin tear down.

Note: *With the complete boom setting upside down, the second boom section, tilt cylinder and hoses are made more accessible. This also eliminates the need to remove the hose rack on the bottom of the boom.*

2. At the boom head, attach a sling through rod end of tilt cylinder. Remove both hoses from tilt cylinder. Plug the hose ends and cap the tilt cylinder fittings to prevent dirt and debris from entering the hydraulic system. Remove the clip from barrel end of tilt cylinder pin. Remove the tilt cylinder pin and lift the tilt cylinder out of the boomhead.
3. At the access panel on the bottom front of the boom, unscrew the tilt and auxiliary hoses. Plug the hose ends to prevent dirt and debris from entering the hydraulic system.

Note: *Tag or identify each hose to the corresponding fitting it was removed from.*

4. Carefully pull the tilt, auxiliary and extend/retract hydraulic hoses (**3**) through the rear of the second boom section.



5. Remove the two snap rings and pin from barrel end of the extend/retract cylinder.

6. Pull the second boom section out 6 in to 8 in (15 cm to 20 cm) to be able to loosen and remove all the bolts and remove all the wear pads, backing plates and shims from the front inside of the first section boom. Tag each pad, backing plate, shim and bolts from each location.

WARNING: **NEVER** weld or drill the boom unless approved in writing by JLG. The structural integrity of the boom will be impaired if subjected to any repair involving welding or drilling. Failure to comply can result in death or severe personal injury.

7. Remove the clip and pin from the rod end of the extend/retract cylinder and pull through the rear of the second boom section.
8. Pull out the remainder of the second boom section.
9. Inspect the boom and welds. Consult your local **JLG** distributor if structural damage is detected.
10. Inspect hoses, hardware, wear pads, mounting points and other components visible with the first boom section. Replace any item if damaged.
11. Inspect all wear pads for wear. (Refer to Section 3.4.1, “Wear Pad Inspection.”)

3.3.3 Second Section Boom Installation

1. Insert the extend/retract cylinder through the rear of the second boom section and attach the pin and clip to the rod end.
2. Install the bottom rear wear pads, washers and bolts into the first boom section. Apply Loctite® #242 and torque to 66 lb-ft (90 Nm). Install the bottom rear left and right side wear pads, backing plate and bolts (do not shim or tighten bolts). Install top rear wear pads, backing plates and bolts (front bolts are drilled and tapped for zerk fittings, do not shim or tighten bolts).
3. Grease the inside of the first boom section on areas where the second boom section wear pads will slide.
4. Using a suitable sling, carefully slide the second boom section 3 ft to 4 ft (1 m to 1.5 m) into the front of the first boom section. Set the second boom section head onto suitable supports and reset sling under the boom head of the second section. Carefully slide the second section into the first section. Leave 6 in to 8 in (15 cm to 20 cm) of the second section out to be able to install wear pads in front of the first boom section.
5. With the sling still under the boom head, install the top wear pads, washers and bolts in the front of the first boom section. Apply Loctite ® #242 and torque to 66 lb-ft (90 Nm). Lower the second boom section and install the bottom wear pads, backing plates, shims and bolts in the front of the first boom section. Apply Loctite® #242 and torque to 66 lb-ft (90 Nm). Install both left and right side front wear pads, backing plates, shims and bolts in the front of the first boom section. Apply Loctite® #242 and torque to 66 lb-ft (90 Nm).

IMPORTANT: *Light lubrication of the boom wear surfaces with a factory authorized grease is recommended to keep the boom wear surfaces lubricated properly.*

6. Tighten all rear wear pad bolts after ensuring the minimum gap requirements have been met. Refer to Section 3.4.1, “Wear Pad Inspection.”
7. Insert the pin and clip into the barrel end of the extend/retract cylinder.
8. Lift the tilt cylinder into place and insert the pins and clips to secure the cylinder to the boomhead.
9. Slide the tilt and auxiliary hoses between the boom sections.
10. Uncap and reconnect the tilt and auxiliary hoses and attach to their appropriate locations.

3.3.4 Boom Installation

IMPORTANT: *Light lubrication of the boom wear surfaces with a factory authorized grease is recommended to keep the boom wear surfaces lubricated properly. Light lubrication of the boom wear surfaces is also recommended when the machine is stored, to help prevent rusting.*

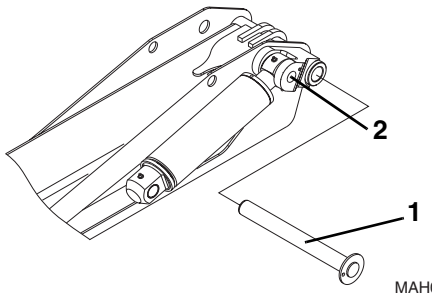
1. Park the machine on a hard, level surface, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Using suitable slings, turn boom back over to original orientation.

Note: *Grease the boom pivot bore, compensating cylinder rod ends, lift/lower cylinder rod end and pins before installing.*

5. Using suitable slings, balance the boom assembly, lift and carefully guide the boom into place. Align the frame pivot bore with the boom assembly pivot bore.

Install boom pivot pin (**1**) and lock bolt. Apply Loctite® #242 and torque to 66 lb-ft (90 Nm).

6. With the sling still in place, install the compensating cylinder, pin (**2**) and lock bolt. Apply Loctite® #242 and torque to 66 lb-ft (90 Nm).



7. With the sling still in place, install the rod end of the lift/lower cylinder, pin and lock bolt. Apply Loctite® #242 and torque to 66 lb-ft (90 Nm).

Note: *Raising the boom up or down with the sling may be necessary so the boom, compensating and lift/lower cylinder bores can be aligned for easier pin installation.*

8. Uncap and reconnect the extend/retract cylinder fittings and plugs from extend/retract cylinder hoses. Attach each hose to the extend/retract cylinder fittings and tighten until wrench-tight. Mark the fitting, then tighten each hose firmly 1 to 1,5 flats.
9. Uncap and reconnect both the tilt and auxiliary hoses. Attach both sets to their appropriate tubes until wrench-tight. Mark the fitting, then tighten each hose firmly 1 to 1,5 flats.
10. Start the engine and operate all boom functions several times to bleed any air out of the hydraulic system. Check for fluid leaks. Check the hydraulic fluid level in the tank and add fluid as required.
11. Clean up all debris, hydraulic fluid, etc., in, on, near and around the machine.
12. Close and secure the engine cover.

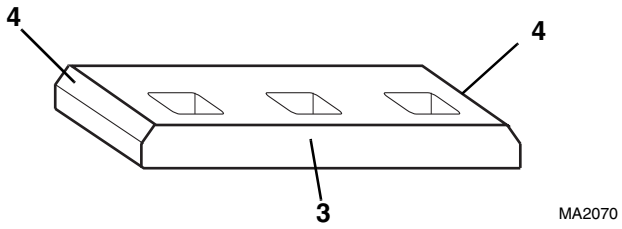
3.4 BOOM WEAR PADS

The wear pads on this machine are flat rectangular wear pads with metal inserts.

On the G5-19A and G6-23A a total of 16 wear pads are installed on the outer boom.

3.4.1 Wear Pad Inspection

Inspect all wear pads (**3**) for wear. If the angle indicators (**4**) on the ends of the wear pads are visible, the wear pads can be reused. If the pads show uneven wear (front to back), they should be replaced. Replace pads as a set if worn or damaged.

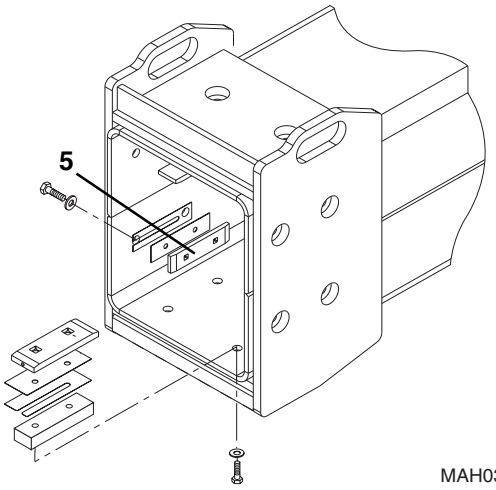


3.4.2 Boom Wear Pad Replacement

When replacing a wear pad on the boom, replace both wear pads on that side of the boom; e.g.: replace top front left and top front right wear pads at the same time.

Usually, shimming will remain the same when installing new wear pads. All wear pads are secured to the boom using different capscrews and washers. When installing new wear pads, apply Loctite® #242 to all wear pad mounting capscrews M10 and torque to 36 lb-ft (50 Nm). Rear upper pads on G6-23A, apply Loctite® #242 to all wear pad mounting capscrews M10 and torque to 66 lb-ft (90 Nm). Grease the new pads and surrounding area.

The boom wear pads (**5**) are mounted on the inside of the first boom section and the outside of the second boom section.



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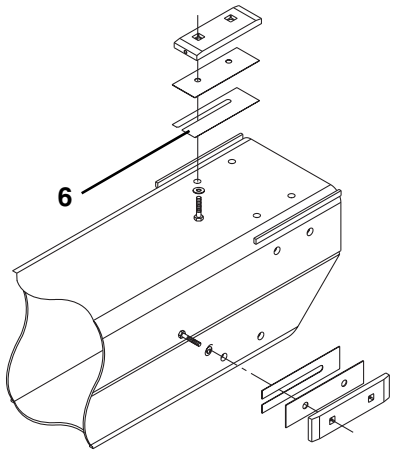

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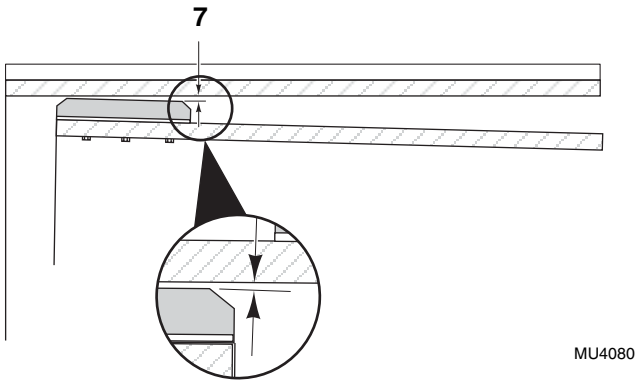
Use shims (**6**) under the wear pads as required to maintain a maximum gap of 0.06 in (1,5 mm) (**7**) between the wear pad on the front and sides of the boom. The gap at the rear of the boom should be no more than 0.12 in (3 mm).

Shims are available in four thicknesses, 0.02 in (0,5mm), 0.04 in (1 mm), 0.06 in (1,5mm) and 0.08 in (2,0mm).



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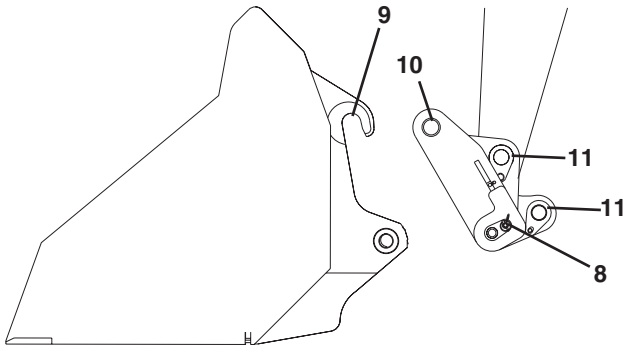
3.4.3 Boom Wear Pad Lubrication

After replacing any wear pad(s), or after prolonged periods of inoperation, light lubrication of the boom wear surfaces with a factory authorized grease is recommended to keep the boom wear surfaces lubricated properly. Light lubrication of the boom wear surfaces is also recommended when the machine is stored, to help prevent rusting.

Note: *The first shim next to the pad needs to be the one with holes, instead of the slots.*

3.5 QUICK SWITCH ASSEMBLY

This machine is equipped with a quick switch system for easy attachment changes.



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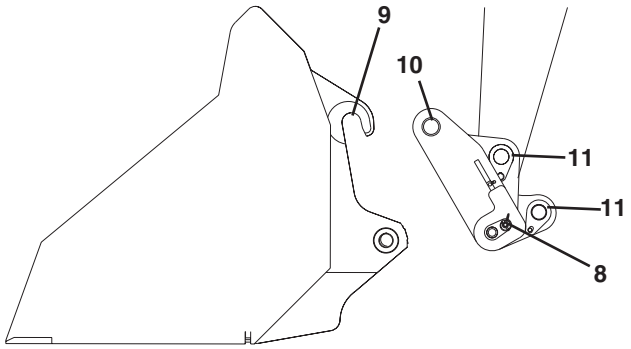
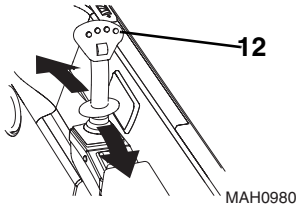
3.5.1 Connecting with a Mechanical Quick Switch Device

1. Retract quick switch device to provide clearance. Check to be sure the retainer pin (**8**) is out.
2. Align attachment pin (**10**) with recess in attachment (**9**). Raise boom slightly to engage attachment pin in recess.
3. Engage quick switch device.
4. Shut off engine. Exit cab and insert lock pin and secure with retainer pin.
5. If attachment is equipped, connect auxiliary hydraulic hoses. See Section 3.5.3, “Connecting with a Quick Switch to a Hydraulic Operated Attachment.”

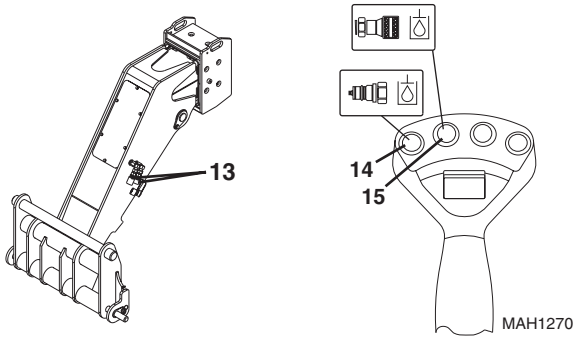


3.5.2 Connecting with a Hydraulic Quick Switch Device

1. Retract quick switch device to provide clearance. Check to be sure lock pin is disengaged.
2. Align attachment pin (**10**) with recess in attachment (**9**). Raise boom slightly to engage attachment pin in recess.
3. Engage quick switch device.
4. Press the button (**12**) and at the same time, move the joystick to engage or to disengage the quick switch device.



5. Raise the boom to eye level and visually check that the quick switch pin protrudes through the hole. If the pin does not protrude through the hole, place the attachment on the ground and return to step 2.
6. If attachment is equipped, connect auxiliary hydraulic hoses. See Section 3.5.3, “Connecting with a Quick Switch to a Hydraulic Operated Attachment.”



3.5.3 Connecting with a Quick Switch to a Hydraulic Operated Attachment

1. Lower attachment to ground and set parking brake.
2. Quickly depress and release button (**14**) to relieve pressure at the male auxiliary fitting.
3. Connect to the male auxiliary fitting (**13**).
4. Quickly depress and release button (**15**) to relieve pressure at the female auxiliary fitting.
5. Connect to the female auxiliary fitting (**13**).

3.5.4 Quick Switch Removal

1. Remove the lock bolt (**11**) holding the tilt cylinder rod end pin to the quick switch assembly. Remove the tilt cylinder pin.
2. Support the quick switch assembly. Remove the pin from the quick switch assembly from either side.
3. Inspect the above pin for nicks or surface corrosion. Use fine emery cloth to fix minor nicks or corrosion. If damaged or if it cannot be repaired the pin must be replaced.

3.5.5 Quick Switch Installation

1. Assemble the quick switch to the boom head. Line up the quick switch between the mounts on the boom head. The quick switch should be centered in the boom head.
2. Coat the quick switch pivot pin with an anti-seize compound. Insert the quick switch pivot pin through the quick switch and boom head.
3. Align the quick switch with the tilt cylinder rod end and insert the tilt cylinder pin. Align the tilt cylinder pin and screw in the lock bolt (**11**). Torque to 72 lb-ft (97 Nm).

3.6 TROUBLESHOOTING

This section provides an easy reference guide covering the most common problems that occur during operation of the boom.

Boom Troubleshooting

Problem	Cause	Remedy
1. Boom will not extend or retract.	1. Broken hydraulic hose(s) or tube(s) and/or connections leaking.	1. Locate break, replace hose(s) or tube(s), tighten connections.
	2. Extend/Retract hydraulic system not operating properly.	2. Refer to Section 8, “Hydraulic System.”
	3. Faulty extend/retract cylinder.	3. Repair cylinder (Refer to Section 8.11.4, “Cylinder Inspection.”)
2. Boom will not fully extend.	1. Extend/retract hydraulic system not operating properly.	1. Refer to Section 8, “Hydraulic System.”
3. Boom shifts to right or left when extending.	1. Boom side wear pads improperly shimmed or worn.	1. Shim wear pads to correct gap. Replace wear pads as needed. Refer to Section 3.4.2, “Boom Wear Pad Replacement.”
4. Excessive pivot pin noise and/or wear.	1. Insufficient lubrication.	1. Lubricate at regular intervals. (Refer to Section 2.6, “Lubrication Schedules.”) Replace worn pins as needed.
	2. Worn bushing(s).	2. Replace bushing(s) and lubricate at regular intervals (Refer to Section 2.6, “Lubrication Schedules.”)
5. Boom will not raise or lower.	1. Broken hydraulic hoses or tubes and/or connection leaks.	1. Locate break, replace hose(s) or tube(s), tighten connections.
	2. Lift/lower hydraulic system not operating properly.	2. Refer to Section 8, “Hydraulic System.”
	3. Faulty Lift cylinders.	3. Repair cylinder. (Refer to Section 8.11.4, “Cylinder Inspection.”)
	4. Seized boom pivot pin bushing.	4. Replace bushing.

Boom Troubleshooting (Continued)

Problem	Cause	Remedy
6. Rapid boom pad wear.	1. Incorrect wear pad gap.	1. Check wear pad gaps and correct as needed. Refer to Section 3.4.2, “Boom Wear Pad Replacement.”
	2. Rapid cycle times with heavy loads.	2. Reduce cycle times.
	3. Contaminated, corroded or rusted wear pad sliding surfaces.	3. Remove contamination and/or corrosion from wear pad sliding surfaces and lubricate. If the surfaces cannot be reconditioned, replace the boom section(s).
	4. Operating in extremely dusty/ abrasive conditions.	4. Clean equipment frequently.
7. Auxiliary hydraulics will not operate.	1. Auxiliary hydraulic system not operating properly.	1. Refer to Section 8, “Hydraulic System.”

Section 4
Cab and Covers

Contents

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4.3		**Cab Components**	**4.3**
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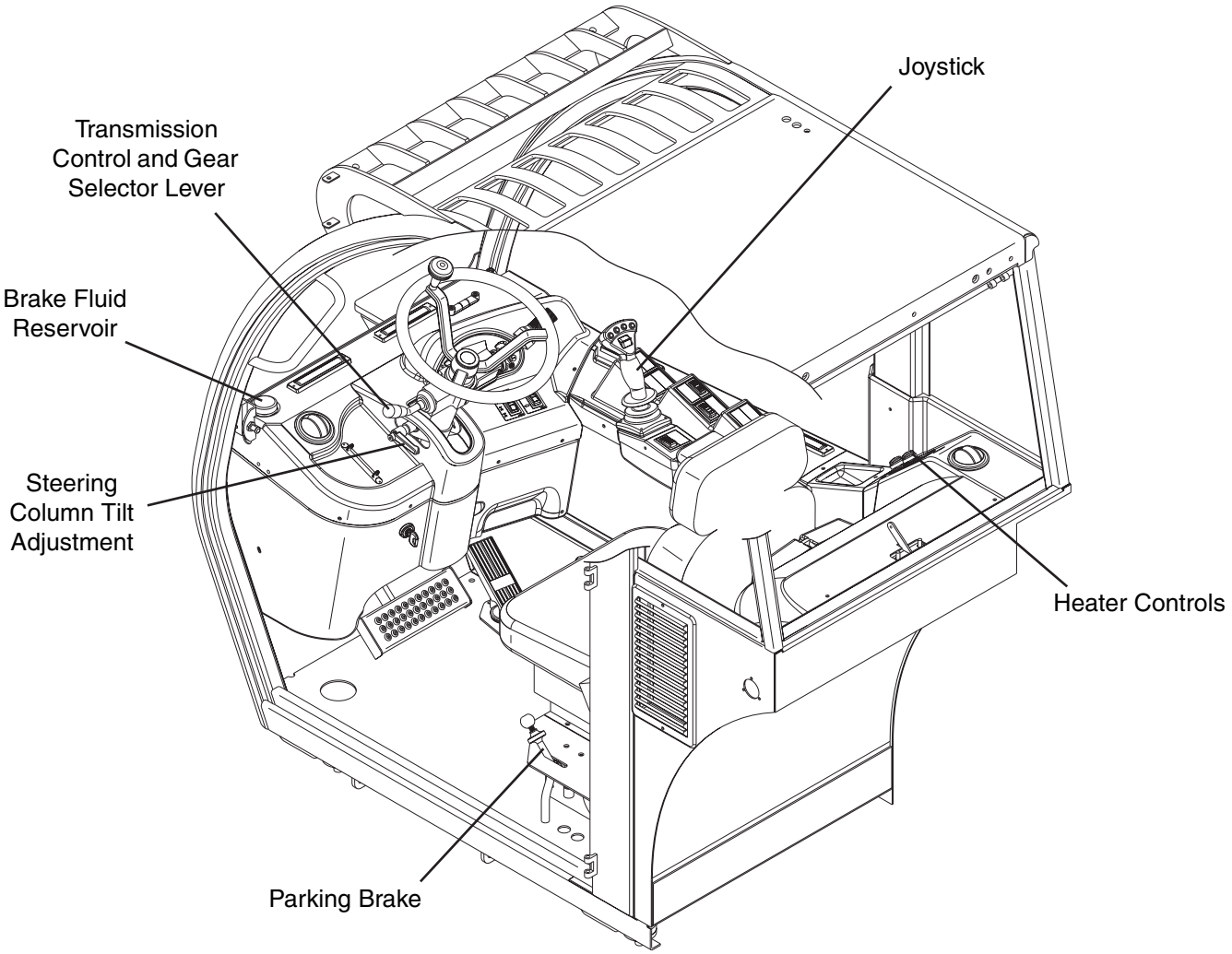
4.5		**Cab Installation**	**4.10**

4.1 OPERATOR'S CAB AND COVERS COMPONENT TERMINOLOGY

To understand the safety, operation and maintenance information presented in this section, it is necessary that the operator/mechanic be familiar with the names and locations of the major assemblies of the machine cab and covers. The following illustration identifies the components that are referred to throughout this section.



WARNING: **DO NOT** service the machine without following all safety precautions as outlined in the “Safety Practices” section of this manual. Failure to follow the safety practices may result in death or serious injury.

4.2 OPERATOR’S CAB

4.2.1 Operator’s Cab Description

The welded metal cab features a modular design, allowing for a relatively quick, simple exchange of the entire cab and/or component parts. The cab is bolted directly to the frame.

The operator’s cab is a protective structure. The cab itself contains rollover protective and falling object protective structures (ROPS/FOPS) for the operator.

DO NOT weld, grind, drill, repair or modify the cab in any way. Any modification or damage to cab structural components requires cab replacement. The lives of the operator and others are potentially at stake.

To help ensure optimum safety, protection and performance, replace the cab if it is damaged. Refer to the appropriate parts manual for ordering information.

The cab contains the seat, operating controls, numerous panels, steering and brake components, and more.

Covers and mirrors on the machine exist for safety, protection and appearance. They are relatively simple to remove and replace.

4.2.2 Serial Number Decal

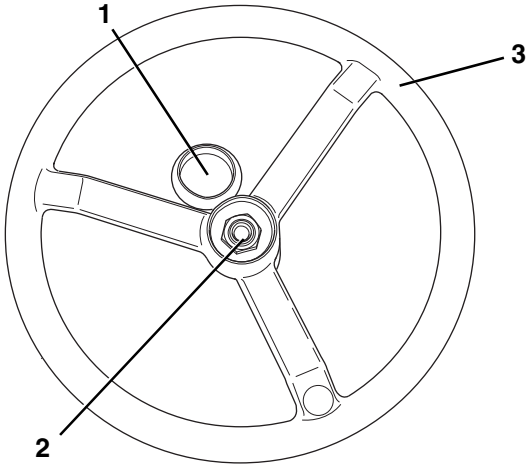
The cab serial number decal is located inside the cab, under the seat. Information specified on the serial number plate includes the cab model number, the cab serial number and other data. Write this information down in a convenient location to use in cab correspondence.

4.3 CAB COMPONENTS

4.3.1 Steering Wheel

a. Steering Wheel Removal

1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Remove the battery negative (-) cable from the battery negative (-) terminal.
5. Carefully pry the center button (**1**) out of the steering wheel.
6. Mark the steering wheel and shaft to ensure proper installation. Remove the nut (**2**) securing the steering wheel (**3**) to the splined steering column shaft.
7. Use a steering wheel puller to remove the steering wheel (**3**) from the splined shaft.



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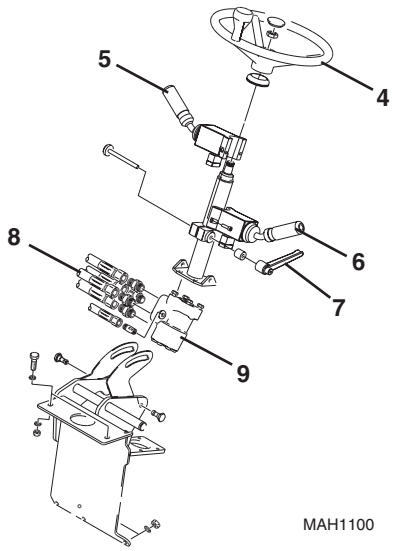
b. Steering Wheel Installation

1. Install the steering wheel (**3**) onto the splined steering column shaft.
2. Secure the steering wheel with the nut (**2**).
3. Press the center button (**1**) onto the steering wheel.
4. Connect the battery negative (-) cable to the battery negative (-) terminal.
5. Close and secure the engine cover.

4.3.2 Steering Column/Valve Replacement

a. Steering Column and Valve Removal

1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Disconnect the battery negative (-) cable at the battery negative (-) terminal.
5. Remove the steering wheel (**4**) (Refer to Section 4.3.1, “Steering Wheel.”), transmission control lever (**6**) and accessory lever (**5**).
6. Remove the steering column tilt lever (**7**).
7. Remove the lower dash panel.
8. Label, disconnect and cap the hydraulic hoses (**8**) and fittings on the steering orbitrol valve (**9**).



9. Remove the two pivot bolts for the steering column and steering orbitrol valve.
10. Pull the steering column assembly from the machine cab.
11. Remove the four hex-flange capscrews connecting the orbitrol valve to the steering column.

Note: ***DO NOT*** *disassemble the steering orbitrol valve. The steering orbitrol valve is not serviceable and must be replaced in its entirety, if defective.*

b. Steering Column and Valve Installation

1. Install the orbitrol valve onto the steering column. Torque the four capscrews to 13 lb-ft (18 Nm). Position the steering valve in the cab, with the ports pointing toward their original orientation.
2. Secure the assembly with the two pivot bolts.

Note: *ALWAYS use new o-rings when servicing the machine.*

3. Uncap and install new o-rings into the fittings. Lubricate the o-rings with clean hydraulic oil.
4. Uncap and reconnect the previously labeled hydraulic hoses to their appropriate locations.
5. Install the steering column tilt knob.
6. Install the steering wheel (Refer to Section 4.3.1, “Steering Wheel.”), accessory lever and transmission control lever.
7. Connect the battery negative (-) cable to the battery negative (-) terminal.
8. Carefully examine all connections one last time before engine start-up. Rectify any faulty conditions.
9. Start the engine and check the operation of all controls. Check for fluid leaks. Check the hydraulic fluid level in the tank and add fluid as required.
10. Install the lower dash panel.
11. Close and secure the engine cover.

c. Power Steering Test

Conduct a pressure check of the steering hydraulic circuits at the test port on the implement pump. Refer to Section 8.5.5, “Steering Pressure Checking.”

4.3.3 Brake Pedal and Valve

a. Brake Valve Removal

Refer to Section 8.10.2, a. “Service Brake Valve Removal,” for removal information.

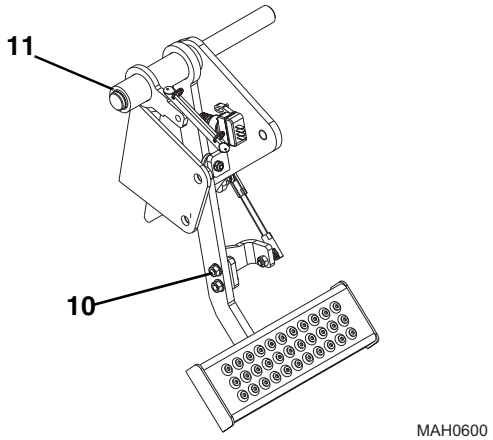
b. Brake Valve Installation

Refer to Section 8.10.2, b. “Service Brake Valve Installation,” for installation information.

c. Service Brake Pedal Removal

1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.

2. Place an Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Disconnect the battery negative (-) cable at the battery negative (-) terminal.
5. Remove the lower dash panel.



6. Remove the two capscrews (**10**) securing the brake pedal to the inching valve.
7. Remove the circlip (**11**), flat washer, and the return spring securing the service brake pedal to the cab.
8. Remove the clip/pin from the brake plunger fork link.
9. Remove the service brake pedal from the cab.

d. Service Brake Pedal Installation

1. Position the service brake pedal in its mounting location within the cab.
2. Install the brake pedal being careful to reposition the brake plunger yoke. Install the return spring, washer and clip. Install clip/pin in brake plunger fork link.
3. Adjust the brake pedal as needed.
4. Install and secure the lower dash cover.
5. Connect the battery negative (-) cable to the battery negative (-) terminal.
6. Close and secure the engine cover.

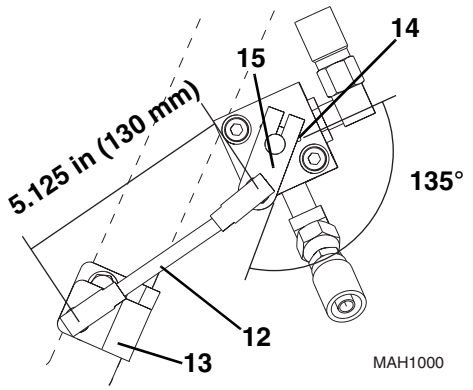
4.3.4 Inching Valve

a. Inching Valve Removal

1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Disconnect the battery negative (-) cable at the battery negative (-) terminal.
5. Remove the lower dash panel.
6. Remove the nut holding the inching valve adjusting rod (**12**) to the brake pedal bracket (**13**).
7. Label and disconnect all hoses attached to the valve, cap all fittings and plug hoses to keep dirt & debris from entering hydraulic system.
8. Remove the two bolts securing the inching valve to the inside of the cab.

b. Inching Valve Installation

1. Install the inching valve with the two bolts inside the cab.
2. Uncap and reconnect the previously labeled hydraulic hoses to the appropriate locations.
3. Point the pin (**14**) on the pivoting part of the valve towards the top T-port. Be sure the brake pedal is in the UP position.
4. Mount the inching valve lever (**15**) to the inching valve. The lever should be 135° ±1° to the pin.
5. Install the adjustable rod (**12**) to the lever. The lever should be set to approximately 5.125 in (130 mm) in length.



Note: *The dimensional values given for inching valve adjustment are to be used as a starting point. More thorough adjusting may be required.*

6. Install and secure the lower dash panel.
7. Connect the battery negative (-) cable to the battery negative (-) terminal.

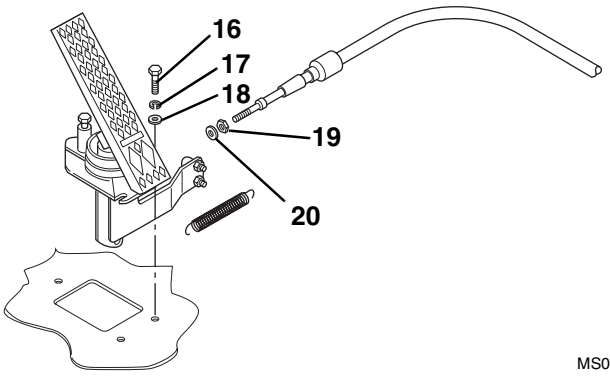
Note: *Check for leaks, and repair as required before continuing. Add hydraulic fluid to the reservoir as needed.*

8. Close and secure the engine cover.

4.3.5 Throttle Pedal Replacement

a. Throttle Pedal Removal

1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Disconnect the battery negative (-) cable at the battery negative (-) terminal.
5. Remove three capscrews (**16**), three lockwashers (**17**) and three washers (**18**) securing the throttle pedal assembly to the cab floor.
6. Remove the hex jam nut (**19**) and flat washer (**20**) securing the throttle cable to the throttle pedal assembly.
7. Remove the clip/pin from the fork link.
8. Remove the throttle pedal assembly from the cab.



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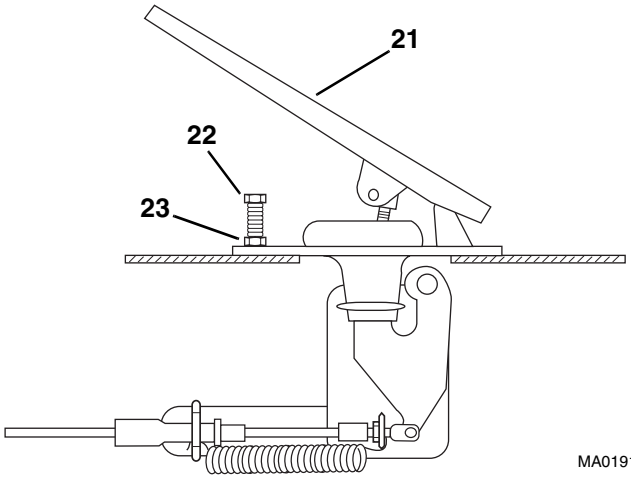
b. Throttle Pedal Installation

1. Install the hex jam nut and flat washer onto the end of the throttle cable. Secure the cable to the throttle pedal. Secure the cable to the throttle pedal with the clip/pin.
2. Align the throttle pedal assembly with its mount holes on the cab floor.
3. Install three capscrews securing the throttle pedal assembly to the cab floor. Torque the capscrews to 9 lb-ft (12 Nm).
4. Connect the battery negative (-) cable to the battery negative (-) terminal.
5. Close and secure the engine cover.

c. Throttle Adjustment

1. From within the cab, lightly depress the accelerator pedal (**21**) to the full-throttle position. As needed, adjust the limit-stop screw (**22**) until it touches the pedal. Tighten the locknut (**23**).



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IMPORTANT: *During the full throttle check:*

- ***DO NOT*** *operate any hydraulic function.*
- ***DO NOT*** *steer or apply any pressure to the steering wheel.*
- *Keep the transmission in (N) NEUTRAL.*

2. Check the engine rpm at full throttle. If the rpm is not 2370 ±50 rpm, readjust the throttle limit-stop screw at the throttle pedal within the cab.

4.3.6 Joystick Assembly Replacement

a. Joystick Assembly Removal

1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and steering wheel, stating that the machine should not be operated.
3. Disconnect the battery negative (-) cable at the battery negative (-) terminal.
4. Remove the two capscrews. Remove the bottom cover.
5. Disconnect the electrical connections and remove the four self-tapping screws from the bottom of the joystick assembly.
6. Remove the joystick assembly.

b. Joystick Assembly Installation

1. Set the joystick assembly into the armrest support.
2. Install the four self-tapping screws. Connect the electrical connections.
3. Connect the battery negative (-) cable to the battery negative (-) terminal.
4. Close and secure the engine cover.
5. Test the boom joystick functions:

Test the boom joystick functions to ensure they match the control pattern on the joystick decal located inside cab.

6. Install the bottom cover and secure using two lens-head capscrews.

4.3.7 Windshield Wiper Assembly

Refer to Section 9.9.1, “Windshield Wiper Motor,” for removal and installation information.

4.3.8 Windshield Washer Assembly

Refer to Section 9.9.2, “Windshield Washer Reservoir and Pump,” for removal and installation information.

4.3.9 Heater/Defroster System

a. Heater Assembly Removal

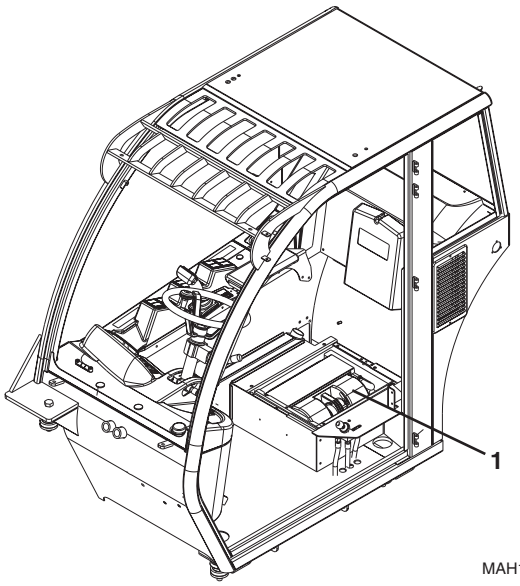
1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Disconnect the battery negative (-) cable at the battery negative (-) terminal.

WARNING: The cooling system is under pressure, and escaping coolant can cause severe burns and eye injury. To prevent personal injury, NEVER remove the radiator cap while the cooling system is hot. Wear safety glasses. Turn the radiator cap to the first stop and allow pressure to escape before removing the cap completely.

5. Place a suitable container beneath the radiator drain plug or petcock. Slowly turn the cap on the coolant overflow bottle to allow any pressure to escape. Remove the overflow bottle cap.
6. Place a funnel at the base of the radiator to channel the drained coolant into the container. Open the radiator drain plug or petcock and allow the coolant to drain. Replace the drain plug, or close the petcock.
7. Transfer the coolant into a suitable, covered container, and label as "Used Coolant". Dispose of used coolant at an approved recycling facility.

Note: *Label all hoses to ensure correct installation.*

8. Remove the seat from the cab to expose the heater/defroster element (**1**).
9. Loosen the hose clamps and disconnect the two heater hoses.



10. Remove the button-head capscrews, nuts and lockwashers securing the heater assembly to the cab.
11. Carefully pull out the heater assembly. Label and disconnect the wiring harness connections at the blower.
12. Remove the heater assembly.

b. Heater Assembly Installation

1. Install the heater assembly to its original orientation.
2. Connect the wiring harness connections at the blower.
3. Install the button-head capscrews, nuts and lockwashers to secure the heater assembly to the cab.
4. Reconnect the two heater hoses.
5. Refill the cooling system at the coolant overflow bottle with a 50/50 mixture of ethylene glycol and water allowing time for the coolant to fill the engine block. See Section 2.4, “Fluids, Lubricants and Capacities,” for system capacities.
6. Connect the battery negative (-) cable at the battery negative (-) terminal.
7. Start the engine, run it briefly at low idle and check the machine for any visual sign of fluid leakage. STOP the machine immediately if any leakage is noted, and make any necessary repairs before continuing.
8. Install the seat in the cab.
9. Check the coolant level. Add or remove fluid as required.
10. Close and secure the engine cover.

4.4 CAB REMOVAL

IMPORTANT: *To help ensure safety and optimum performance, replace the cab if it is damaged. Refer to the appropriate parts manual for ordering information.*

Before performing any inspection, maintenance or service operation, thoroughly clean the machine. **DO NOT** spray water or cleaning solution in, on, near or around the operator’s dash panels and electrical components.

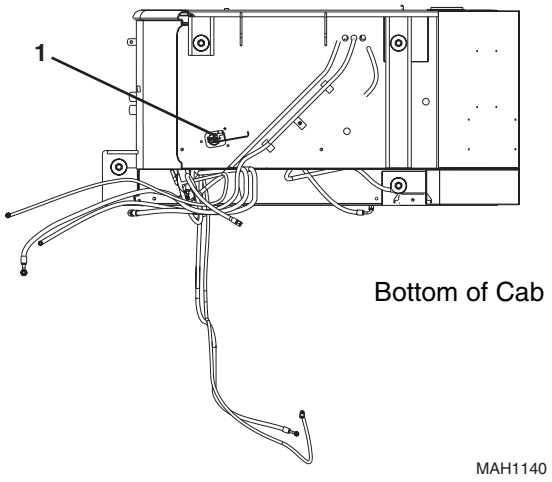
Inspect the cab, its welds and mounts. If modification, damage, a cracked weld and/or fatigued metal is discovered, replace the cab. Contact your local **JLG** distributor with any questions about the suitability or condition of a cab.

IMPORTANT: *Remove and label cab components as needed before removing the cab from the machine. Label, disconnect and cap hydraulic hoses. Transfer cab parts to the replacement cab after the replacement cab is securely mounted on the machine.*

1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Block the wheels to ensure that the machine does not move.
3. Open the engine cover. Allow the system fluids to cool.
4. Disconnect the battery negative (-) cable at the battery negative (-) terminal.

Note: *Steps 5 through 8 are only required if machine is equipped with heating or heating/air conditioning.*

5. Place a suitable container beneath the radiator drain plug or petcock. Slowly turn the cap on the coolant overflow bottle to allow any pressure to escape. Remove the overflow bottle cap.
6. Place a funnel at the base of the radiator to channel the drained coolant into the container. Open the radiator drain plug or petcock and allow the coolant to drain. Replace the drain plug or close the petcock.
7. Transfer the coolant into a suitable, covered container, and label as "Used Coolant". Dispose of used coolant at an approved recycling facility.

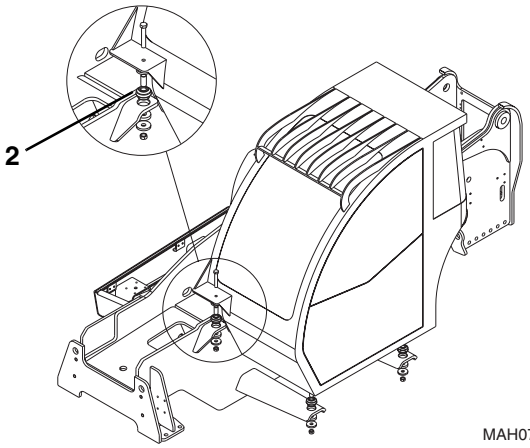


Note: *Label all hoses to ensure correct installation.*

8. Loosen the hose clamps, and disconnect the heater hoses from the engine. Cap or plug the hoses to prevent debris from entering the heater system.
9. Disconnect the cab-to-wiring harness connectors.

Note: *Record the location, and label all cables to ensure correct installation.*

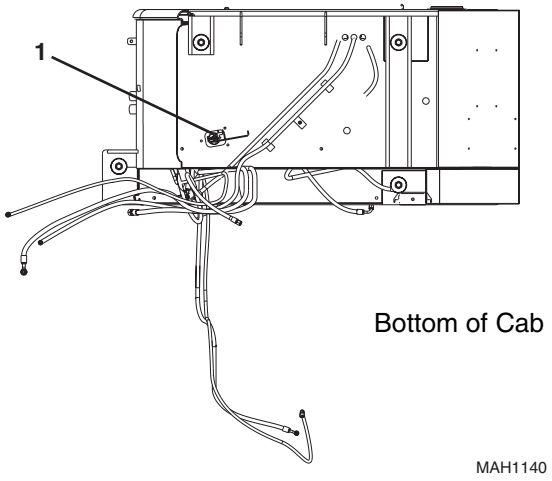
10. Working underneath the cab, label and disconnect the hydraulic hoses at the cab fittings. Plug the hoses and cap the fittings.
11. Disconnect the throttle cable rod end at the throttle lever extension bracket (**1**). Route the cable away from the cab to prevent damage during removal.
12. Install two lifting eye bolts with a suitable lifting capacity in the existing threaded holes at the top corners of the windshield.
13. Remove the cab-to-frame bolts (**2**), washers and nuts.



14. Carefully begin to lift the cab. Stop and check that all wiring, hydraulic hoses and fasteners are disconnected or removed. Do not damage the fuel fill tube.
15. When all wiring, hydraulic hoses and fasteners are disconnected or removed, carefully and slowly lift the cab and remove it from the frame. Readjust the position of the sling as needed to help balance the cab during removal.
16. When the cab is completely clear of the machine, carefully lower it to the ground. Block up or support the cab.
17. Inspect the condition of the fittings, clamps, hydraulic hoses, etc. Replace parts as indicated by their condition.
18. Inspect and replace other machine parts that are exposed with the cab removed. Repair or replace as required.

4.5 CAB INSTALLATION

1. Block all four wheels to help prevent the machine from moving. Assure that there is sufficient overhead and side clearance for cab installation.
2. Attach a sling with suitable lifting capacity through the previously installed eye bolts.
3. Use a hoist or overhead crane and sling attached to the cab. Carefully begin to align the cab with the mounting holes in the frame. Stop and check that wiring, hydraulic hoses, cables, etc., will not be pinched or damaged as the cab is positioned. Take special note of the fuel fill tube as well. Readjust the position of the sling as needed to help balance the cab during installation.
4. Install the cab-to-frame bolts, washers and nuts. Torque to 110 lb-ft (150 Nm).
5. Remove the eye bolts from the top of the cab.



6. Connect the throttle cable rod end to the throttle extension bracket (**1**) underneath the cab.
7. Uncap and reconnect the hydraulic hoses at the cab locations.
8. Secure the throttle cable to the hydraulic hoses using wire ties.
9. Uncap and connect the heater hoses to the engine. Secure with hose clamps.
10. Install the cab-to-wiring harness connectors on side of the cab.
11. Fill the cooling system completely with a 50/50 mixture of ethylene glycol and water, allowing time for the coolant to fill the engine block. The cooling system capacity is listed in Section 2.4, “Fluids, Lubricants and Capacities.”
12. Connect the battery negative (-) cable to the battery negative (-) terminal.
13. Carefully examine all cab components, fasteners, etc., one last time before engine start-up. Rectify any faulty conditions.
14. Start the engine and check the operation of all controls. Check for hydraulic fluid leaks. Check the hydraulic fluid level in the tank and add fluid as required.

IMPORTANT: *When the engine is initially started, run it briefly at low idle and check the machine for any visual sign of fluid leakage. STOP the engine immediately if any leakage is noted, and make any necessary repairs before continuing.*

15. Wait for the engine to cool and check the coolant level. Add coolant to the overflow bottle as required to bring the coolant to the proper level.
16. Close and secure the engine cover.

Section 5
Axles, Drive Shafts, Wheels and Tires

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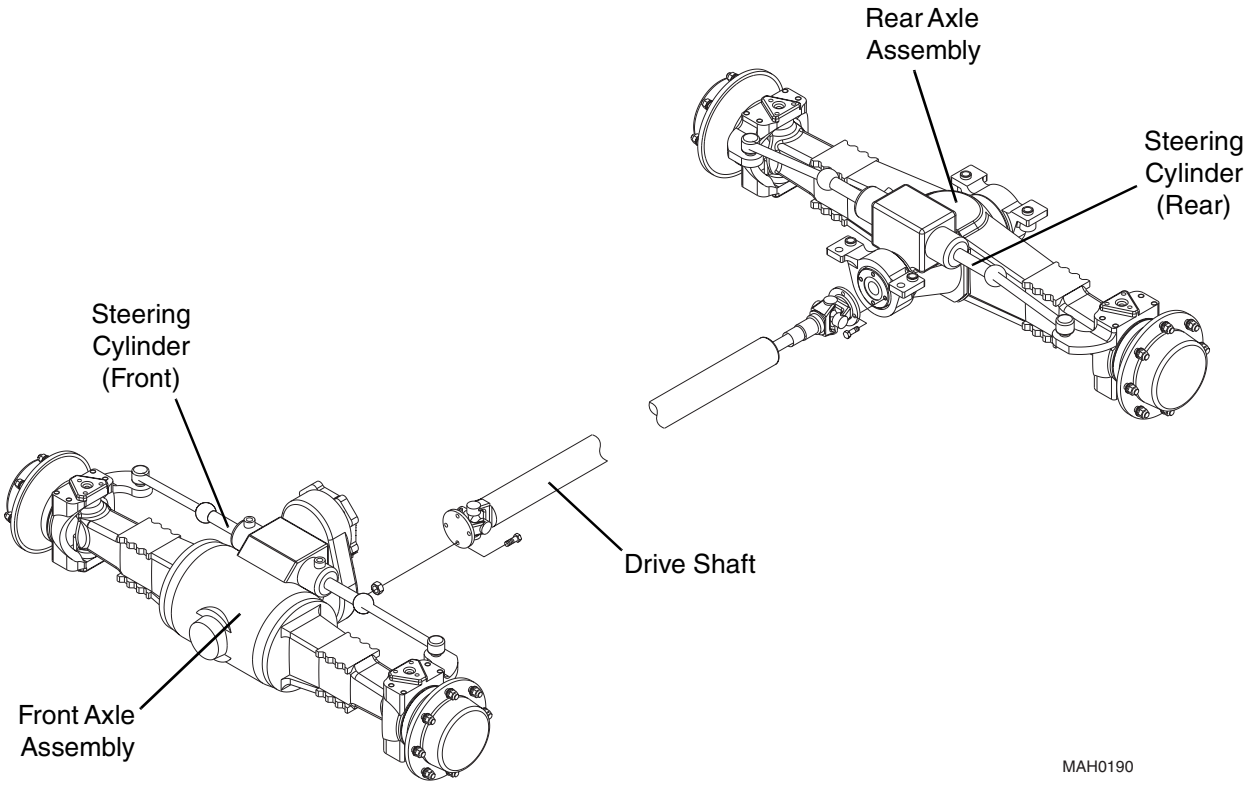
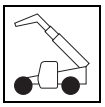
5.1 AXLE, DRIVE SHAFT AND WHEEL COMPONENT TERMINOLOGY

To understand the safety, operation and maintenance information presented in this section, it is necessary that the operator/mechanic be familiar with the names and locations of the major assemblies of the axles, drive shafts, wheels and tires. The following illustration identifies the components that are referred to throughout this section.





5.2 GENERAL INFORMATION

Before performing any inspection, maintenance or service operation, thoroughly clean the unit. The axles and drive shafts should be checked and repaired only by experienced service technicians who are aware of all safety instructions and particular component features.

Use suitable products to thoroughly clean all disassembled mechanical parts to help prevent personal injury to the worker and prevent damage to the parts. Carefully inspect the integrity of all moving parts (bearings, yokes, tubes, gears, shafts, etc.) and fasteners (nuts, bolts, washers, etc.) as they are subject to major stress and wear. Always replace elastic locknuts and any damaged, worn, cracked, seized or otherwise improper parts that could affect the safe and proper functioning of the machine, axles and drive shafts.

5.3 AXLE ASSEMBLIES

5.3.1 Axle Serial Number Plate

The axle serial number plate is located on the inside of the right yoke. Information on the serial number plate is required in correspondence regarding the axle.

Supply information from the axle serial number plate when communicating about an axle assembly or axle components.

5.3.2 Axle Specifications

General axle specifications are found in Section 2, “General Information and Specifications.” Axle (differential housing) fluid information is found in Section 2.4, “Fluids, Lubricants and Capacities.”

5.3.3 Axle Internal Service

Detailed axle service instructions (covering the axle, differential, brakes and wheel-end safety, repair, disassembly, reassembly, adjustment and troubleshooting information) are provided in the following manuals.

Machine	Carraro Model	Axle	JLG MANUAL
G5-19A	141154	FRONT	31200119
G5-19A	141155	REAR	31200120
G6-23A	139970	FRONT	31200121
G6-23A	141247	REAR	31200122

WARNING: **DO NOT** service the machine without following all safety precautions as outlined in Section 1, “Safety Practices,” of this manual. Failure to follow the safety practices may result in death or serious injury.

5.3.4 Axle Maintenance

CLEANING: Clean parts with machined or ground surfaces (such as gears, bearings and shafts) with emulsion cleaners or petroleum-based cleaners. **DO NOT** steam clean internal components and the interior of the planetary hub and axle housing. Water can cause corrosion of critical parts. Rust contamination in the lubricant can cause gear and bearing failure. Remove old gasket material from all surfaces.

DRYING: Use clean, lintless towels to dry components after cleaning. **DO NOT** dry bearings by spinning them with compressed air; this can damage mating surfaces due to lack of lubrication. After drying, lightly coat components with oil or a rust-preventive chemical to help protect them from corrosion. If storing components for a prolonged period, wrap them in wax paper.

PERIODIC OPERATION REQUIREMENT: Every two weeks, drive the machine far enough to cause the drive-train components to make several complete revolutions. This will help ensure that internal components receive lubrication to minimize deterioration caused by environmental factors such as high humidity.

SUBMERSION: If the machine has been exposed to water deep enough to cover the hubs, disassemble the wheel ends and inspect for water damage and contamination. If the carrier housing was submerged in

water, especially if the water level was above the vent tube (breather), drain the axle and inspect internal parts for water damage and contamination. Before assembling and refilling the unit with the specified lubricant(s), clean, examine and replace damaged parts as necessary.

Note: *Use a suitable puller for bearing removal. Clean, inspect and lubricate all bearings just prior to reassembly. If replacement of a damaged bearing cup or cone is necessary, replace the cup and cone as a set.*

5.3.5 Axle Removal

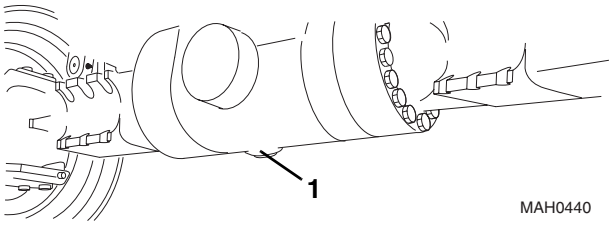
WARNING: An improperly supported machine can fall, causing death or severe personal injury. Safely raise and adequately support the machine so that it will remain stable and in place before attempting to remove an axle.

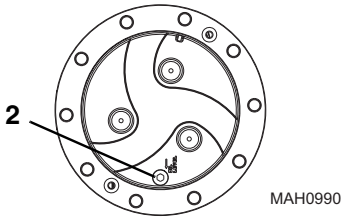
The front and rear axle assemblies differ in that the front axle assembly is equipped with a hydraulic drive pump, parking brake mechanism and a limited-slip feature; the rear axle has none of these. The following steps outline a typical axle removal procedure, suitable for either the front or the rear axle assembly.

Cleanliness is extremely important. Before attempting to remove the axle, thoroughly clean the machine. Avoid spraying water or cleaning solution on the stabilizer solenoids and other electrical components. If using a steam cleaner, seal all openings before steam cleaning.

IMPORTANT: *Clear the work area of all debris, unnecessary personnel, etc. Allow sufficient space to raise the machine and to remove the axle.*

1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Disconnect the battery negative (-) cable at the battery negative (-) terminal.
5. If the axle will be disassembled after removal, the oil will have to be drained. Loosen the breather to release possible internal pressure, then tighten breather with a torque wrench to 9 lb-ft (12 Nm).
6. If the axle will be disassembled after removal, place a suitable receptacle under the axle (**1**) and wheel hubs (**2**) drain plugs. Remove the drain plugs and allow the axle oil to drain into the receptacle. Transfer the used axle oil into a suitable covered container, and label the container as "Used Oil." Dispose of the used oil at an approved recycling facility.

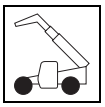




7. Label, disconnect and cap the steering and brake lines at the axle. Wipe up any spilled oil.
8. Block the front and rear of both tires on the axle that is not being removed. Ensure that the machine will remain in place during axle removal before proceeding.
9. Raise the machine using a suitable jack or hoist. Place suitable supports under both sides of the frame and lower the machine onto the supports. Ensure that the machine will remain in place during axle removal.
10. Support the axle that is being removed with a suitable jack, hoist or overhead crane and sling. **DO NOT** raise the axle or the machine.
11. Mark and remove both wheel and tire assemblies from the axle that is being removed. (Refer to Section 5.5.1, “Removing Wheel and Tire Assembly from Machine.”)

Note: *The wheel and tire assemblies must be re-installed later with the directional tread pattern “arrows” facing in the direction of forward travel.*

12. Remove the drive shaft assembly. (Refer to Section 5.4.3, “Drive Shaft Removal.”)
13. Remove the capscrews, locknuts and axle plates securing the axle to the frame.
14. Remove the axle from the machine using the jack, hoist or overhead crane and sling supporting the axle. **DO NOT** raise or otherwise disturb the machine while removing the axle. Balance the axle and



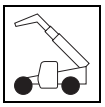
prevent it from tipping, turning or falling while removing it from beneath the machine. Place the axle on a suitable support or holding stand.

5.3.6 Axle Installation

1. Before proceeding, ensure that the machine will remain in place during axle installation. Block the front and rear of both tires on the axle that is already installed on the machine.
2. If applicable, raise the machine using a suitable jack or hoist. Place suitable supports beneath the frame and lower the machine onto the supports, allowing enough room for axle installation. Ensure that the machine will remain in place during axle installation.
3. Using a suitable jack, hoist or overhead crane and sling, remove the axle from its support or holding stand. Balance the axle and prevent it from tipping, turning or falling while positioning it beneath the machine. **DO NOT** raise or otherwise disturb the machine while installing the axle. Keep the axle supported and balanced on the jack, hoist or overhead crane and sling throughout the installation procedure.
4. Position the axle under the frame, and align with the holes in the frame.
5. Install the axle with capscrews, locknuts and the axle plates. Torque the front and rear axles of the **G5-19A** to 495 lb-ft (671 Nm). Torque the front axle of the **G6-23A** to 863 lb-ft (1170 Nm) and the rear axle to 495 lb-ft (671 Nm).
6. Install the drive shaft assemblies. (Refer to Section 5.4.5, “Drive Shaft Installation.”)
7. If reinstalling an axle previously removed from the machine, position the driveshaft yoke on the axle according to the alignment marks made earlier. If installing a new axle, note the position of the driveshaft yoke at the transmission. Align the driveshaft yoke on the axle in the same plane as the yoke on the transmission.
8. Tighten the axle oil drain plug, loosen and remove the axle oil fill plug. Fill axle with the appropriate oil. Refer to Section 2.4, “Fluids, Lubricants and Capacities,” for proper oil and capacities.
9. Rotate wheel hubs 90 degrees so the drain plug becomes the fill plug. Fill wheel hubs with the appropriate oil. Refer to Section 2.4, “Fluids, Lubricants and Capacities,” for proper oil and capacities.
10. Install the wheel and tire assemblies. (Refer to Section 5.5.2, “Installing Wheel and Tire Assembly onto Machine.”)
11. Carefully remove the jack, hoist or overhead crane and sling supporting the axle.
12. Carefully raise the machine using a suitable jack or hoist. Remove the supports from beneath the frame and lower the machine to the ground.
13. Remove the blocks from the front and rear of both tires on the other axle.
14. Uncap and reconnect the steering and brake lines at their axle fittings. Refer to Section 8.10.4, “Brake Test,” for brake bleeding procedures.
15. Check the hydraulic reservoir oil level.
16. Connect the battery negative (-) cable to the battery negative (-) terminal.
17. Close and secure the engine cover.
18. Start the engine. Turn the steering wheel several times lock to lock and check the function of the brakes. Check for hydraulic leaks, and tighten or repair as necessary.

5.3.7 Axle Assembly and Drive Shaft Troubleshooting

Problem	Cause	Remedy
1. Excessive axle noise while driving.	1. Oil level too low.	1. Fill oil to correct level. (Refer to Section 2.4, “Fluids, Lubricants and Capacities.”)
	2. Axle and/or wheel end housings filled with incorrect oil or oil level low.	2. Drain axle and/or wheel end housings and fill to correct level with Mobilube HDLS 80W-90 Fluid. (Refer to Section 2.4, “Fluids, Lubricants and Capacities.”)
	3. Incorrect alignment of ring and pinion gears.	3. Correct alignment by adding or removing shims as needed.
	4. Incorrect pinion (input) shaft bearing preload.	4. Correct bearing preload by adding or removing shims as needed.
	5. Worn or damaged bearings.	5. Replace bearings as needed.
	6. Worn or broken gear teeth.	6. Replace gears as needed.
	7. Contamination in the axle.	7. Drain axle and/or wheel end housings and fill to correct level with Mobilube HDLS 80W-90 Fluid. (Refer to Section 2.4, “Fluids, Lubricants and Capacities.”)
	8. Axle housing damaged.	8. Replace damaged parts.
2. Intermittent noise when traveling.	1. Universal joint(s) worn or damaged.	1. Repair or replace universal joints as needed.
	2. Differential ring and/or pinion gears damaged.	2. Determine cause and repair as needed.
3. Vibration or intermittent noise when traveling.	1. Drive shaft universal joint(s) assembly incorrectly tightened.	1. Tighten capscrews to correct torque.
	2. Drive shaft universal joint(s) worn or damaged.	2. Repair or replace universal joints as needed.
	3. Drive shaft damaged/ unbalanced.	3. Replace drive shaft as needed.



5.3.7 Axle Assembly and Drive Shaft Troubleshooting (Continued)

Problem	Cause	Remedy
4. Oil leaking from axle (differential housing and/or axle housings).	1. Drain plugs loose and/or o-rings damaged or missing.	1. Replace o-rings as needed and tighten plugs 59 lb-ft (80 Nm).
	2. Hose fittings loose.	2. Tighten fittings.
	3. Axle shaft seal damaged or missing and/or worn or damaged shaft sealing surfaces.	3. Replace seal and/or joint coupling fork shaft (axle shaft).
	4. Input shaft multi-seal ring damaged or missing and/or worn or damaged pinion (input) shaft sealing surfaces.	4. Replace multi-seal ring and/or input shaft. Adjust ring and pinion alignment and bearing preload as described in the Carraro Repair Manuals.
	5. Axle casing to brake housing and/or brake housing to differential assembly o-rings and/or seals worn or damaged.	5. Replace o-rings and seals.
	6. Axle housing mounting nuts and capscrews loose.	6. Tighten housing nuts and capscrews to 236 lb-ft (320 Nm).
	7. Differential and/or axle housing(s) damaged.	7. Replace housing(s) as needed.
5. Oil leaking from wheel end housing (planet carrier).	1. Oil level plugs loose and/or o-rings damaged or missing.	1. Replace o-rings as needed and tighten plugs to 59 lb-ft (80 Nm).
	2. O-ring between hub and housing (planet carrier) damaged or missing.	2. Replace o-ring.
	3. Shaft seal damaged or missing and/or worn or damaged shaft sealing surfaces.	3. Replace seal and/or fork joint shaft.
	4. Housing capscrews loose.	4. Tighten housing capscrews to 41 lb-ft (55 Nm).
	5. Housing (planet carrier) damaged.	5. Replace housing (planet carrier).
6. Oil leaking from steering cylinder.	1. Hose fittings loose.	1. Tighten fittings.
	2. Steering cylinder o-rings and/or seals worn or damaged.	2. Replace o-rings and seals.
	3. Piston rod seal worn or damaged.	3. Replace piston rod seal.
	4. Cylinder tube damaged.	4. Replace cylinder tube.

5.3.7 Axle Assembly and Drive Shaft Troubleshooting (Continued)

Problem	Cause	Remedy
7. Axle overheating.	1. Oil level too high.	1. Fill oil to correct level with Mobilube HDLS 80W-90 fluid. (Refer to Section 2.4, “Fluids, Lubricants and Capacities.”)
	2. Axle and/or wheel end housings filled with incorrect oil or oil contaminated or oil level low.	2. Drain axle and/or wheel end housing and fill to correct level with Mobilube HDLS 80W-90 Fluid. (Refer to Section 2.4, “Fluids, Lubricants and Capacities.”)
8. High steering effort required.	1. Steering (hydraulic) system not operating properly.	1. Refer to the appropriate Carraro Repair Manual.
	2. Excessive joint housing swivel bearing preload.	2. Correct bearing preload by adding or removing shims as needed.
	3. Worn or damaged swivel bearings.	3. Replace swivel bearings as needed.
9. Slow steering response.	1. Steering (hydraulic) system not operating properly.	1. Refer to the appropriate Carraro Repair Manual.
	2. Steering cylinder leaking internally.	2. Repair or replace steering cylinder as needed.
10. Excessive noise when brakes are engaged.	1. Brake discs worn.	1. Check brake discs for wear. Refer to appropriate Carraro Repair Manual.
	2. Brake discs damaged.	2. Replace brake discs.
11. Brakes will not engage.	1. Brake (hydraulic) system not operating properly.	1. Refer to the appropriate Carraro Repair Manual.
	2. Brake piston o-rings and seals damaged (leaking).	2. Replace o-rings and seals.
12. Brakes will not hold the machine or braking power reduced.	1. Brake discs worn.	1. Check brake discs for wear. Refer to the appropriate Carraro Repair Manual.
	2. Brake (hydraulic) system not operating properly.	2. Refer to the appropriate Carraro Repair Manual.
	3. Brake piston o-rings and seals damaged (leaking).	3. Replace o-rings and seals.

5.4 DRIVE SHAFTS

5.4.1 Drive Shaft Inspection

Whenever servicing the machine, conduct a visual inspection of the drive shaft and cross and bearing assembly (universal joints, or U-joints). A few moments spent doing this can help prevent further problems and down time later.

Inspect area where the drive shaft flange yoke and slip yoke mount to the drive shaft. Attempt to turn drive shaft in both directions. Look for excessive looseness, missing parts, cracks or other damage. Worn or damaged drive shaft and cross and bearing assembly may cause an excessive amount of vibration or noise.

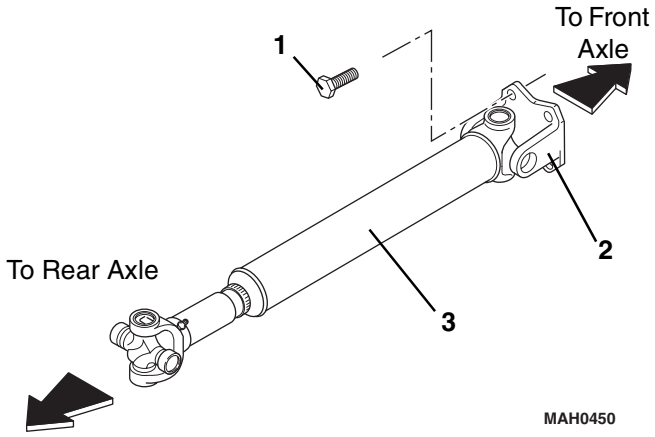
5.4.2 Drive Shaft Maintenance

Refer to Section 2.6, “Lubrication Schedules,” for information regarding the lubrication of the grease fittings on the drive shafts.

5.4.3 Drive Shaft Removal

IMPORTANT: *To help ensure optimum performance, the drive shaft assemblies are specially balanced as a unit at the factory. When servicing, order a complete assembly if components are bent or damaged. Refer to the appropriate parts manual for ordering information.*

1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Disconnect the battery negative (-) cable at the battery negative (-) terminal.
5. The drive shaft assembly is a balanced assembly. Mark the yoke and axle, transmission and the shaft and slip yoke so that these components can be returned to their original positions when reinstalled. Yokes at both ends of the drive shaft must be in the same plane to help prevent excessive vibration.
6. Remove the four capscrews (**1**) and four locknuts securing the yoke flange (**2**) to the front axle flange.
7. Remove the four capscrews securing the flange yoke to the rear axle flange.
8. Remove the drive shaft assembly (**3**).



5.4.4 Drive Shaft Cleaning and Drying

1. Disassemble and clean all parts using an approved cleaning fluid. Allow to dry.
2. Remove any burrs or rough spots from all machined surfaces. Re-clean and dry as required.

5.4.5 Drive Shaft Installation

IMPORTANT: *To help ensure optimum performance, the drive shaft assemblies are specially balanced as a unit at the factory. When servicing, order a complete assembly if components are bent or damaged. Refer to the appropriate parts manual for ordering information.*

1. Raise the drive shaft assembly (**3**) into position. The slip-yoke end of the drive shaft mounts toward the front axle. If reinstalling a drive shaft previously removed, align the flange yokes according to the alignment marks made during removal.

IMPORTANT: *Yokes at both ends of the drive shaft must be in the same plane to help prevent excessive vibration.*

2. Install the four capscrews (**1**) and four locknuts securing the yoke flange (**2**) to the front axle. Loctite® and torque the capscrews to 102 lb-ft (139 Nm).
3. Install the four capscrews securing the bearing crosses to the rear axle. Loctite® and torque the capscrews to 102 lb-ft (139 Nm).
4. Connect the battery negative (-) ground cable at the battery negative (-) terminal.
5. Close and secure the engine cover.

5.5 WHEELS AND TIRES

WARNING: Risk of death or serious personal injury. Mismatched tire sizes, ply ratings or mixing of tire types (radial tires with bias-ply tires) may compromise machine stability and may cause machine to tip over.

JLG recommends a replacement tire to be the same size, ply and brand as originally installed. Refer to the appropriate parts manual for ordering information. If not using a JLG approved replacement tire, JLG recommends that replacement tires have the following characteristics:

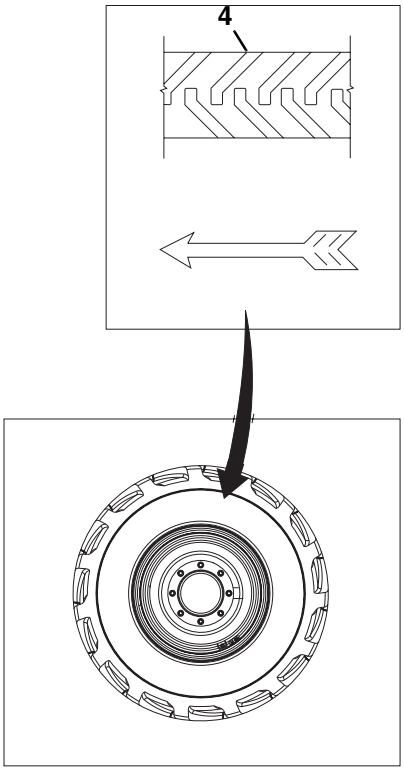
- Equal or greater ply/load rating and size of original.
- Tire tread contact width equal or greater than original.
- Wheel diameter, width and offset dimensions equal to the original.
- Approved for the application by the tire manufacturer (including inflation pressure and maximum tire load).

The rims installed have been designed for stability requirements which consist of track width, tire pressure and load capacity. Size changes such as rim width, center piece location, larger or smaller diameter, etc., without written factory recommendations, may result in unsafe condition regarding stability.

The tires are filled with air only when the machine leaves the factory. JLG does not recommend the use of hydrofill as a tire-fill substance because of possible environmental impact.

Large-bore valve stems are used to help expedite tire inflation and deflation. An inner tube may be used if a tire does not provide an airtight seal. Check tire inflation pressures when the tires are cold. When mounting a tire on the wheel, the tire must be mounted on the wheel respective of the directional tread pattern of the tire; this produces a left or right tire and wheel assembly.

The wheel and tire assemblies must be installed with the directional tread pattern “arrows” (**4**) facing in the direction of forward travel.



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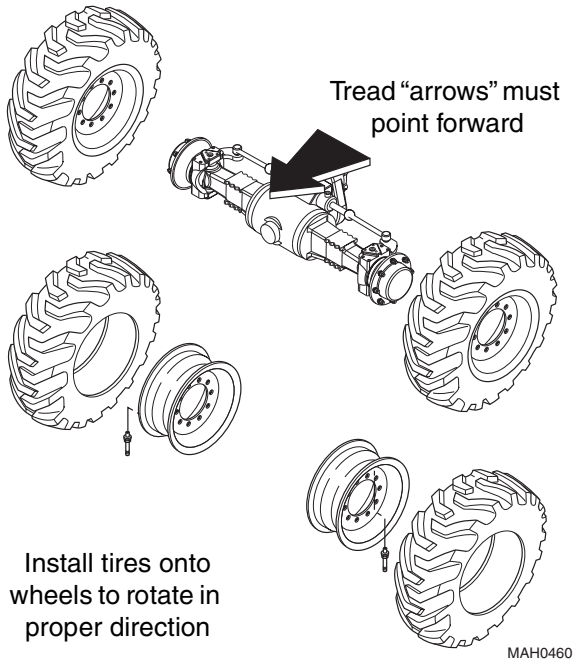
5.5.1 Removing Wheel and Tire Assembly from Machine

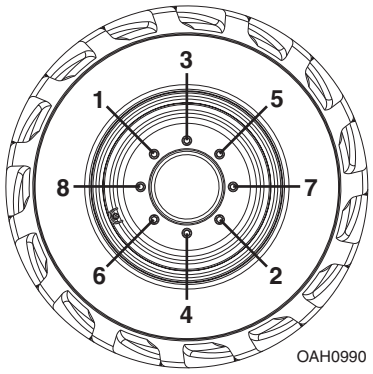
1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and steering wheel, stating that the machine should not be operated.
3. Loosen but **DO NOT** remove the lug nuts on the wheel and tire assembly to be removed.
4. Place a suitable jack under the axle pad closest to the wheel being removed. Raise the machine and position a suitable support beneath the axle. Allow sufficient room to lower the machine onto the support and to remove the wheel and tire assembly.
5. Lower the machine onto the support.
6. Remove lug nuts and lug washers in an alternating pattern.
7. Remove the wheel and tire assembly from the machine.

5.5.2 Installing Wheel and Tire Assembly onto Machine

IMPORTANT: *The wheel and tire assemblies must be installed with the directional tread pattern "arrows" facing in the direction of forward travel.*



1. Position wheel onto studs on wheel end of axle.
2. Install wheel lug washers.
3. Start all nuts by hand to prevent cross threading. DO NOT use a lubricant on threads or nuts.
4. Tighten lug nuts in an alternating pattern as indicated in figure. Torque to 221 lb-ft (300 Nm).



5. Remove machine from supports.

5.6 STEERING ADJUSTMENT

5.6.1 Steering Angle Adjustment

Steering angle adjustment instructions can be found in the appropriate Carraro Repair Manual.

5.7 BRAKES

5.7.1 Brake Disk Inspection.

Check the brake disks for wear every 1,000 hours of operation or yearly.

The service brakes can only be checked by performing a teardown of the axle. Refer to the appropriate Carraro Repair Manual for complete teardown instructions. The minimum tolerance for the brake disc gap is 0.016 in (4.10 mm).

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Section 6
Transmission:

Contents

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6.2		**Transmission Description**	**6.3**
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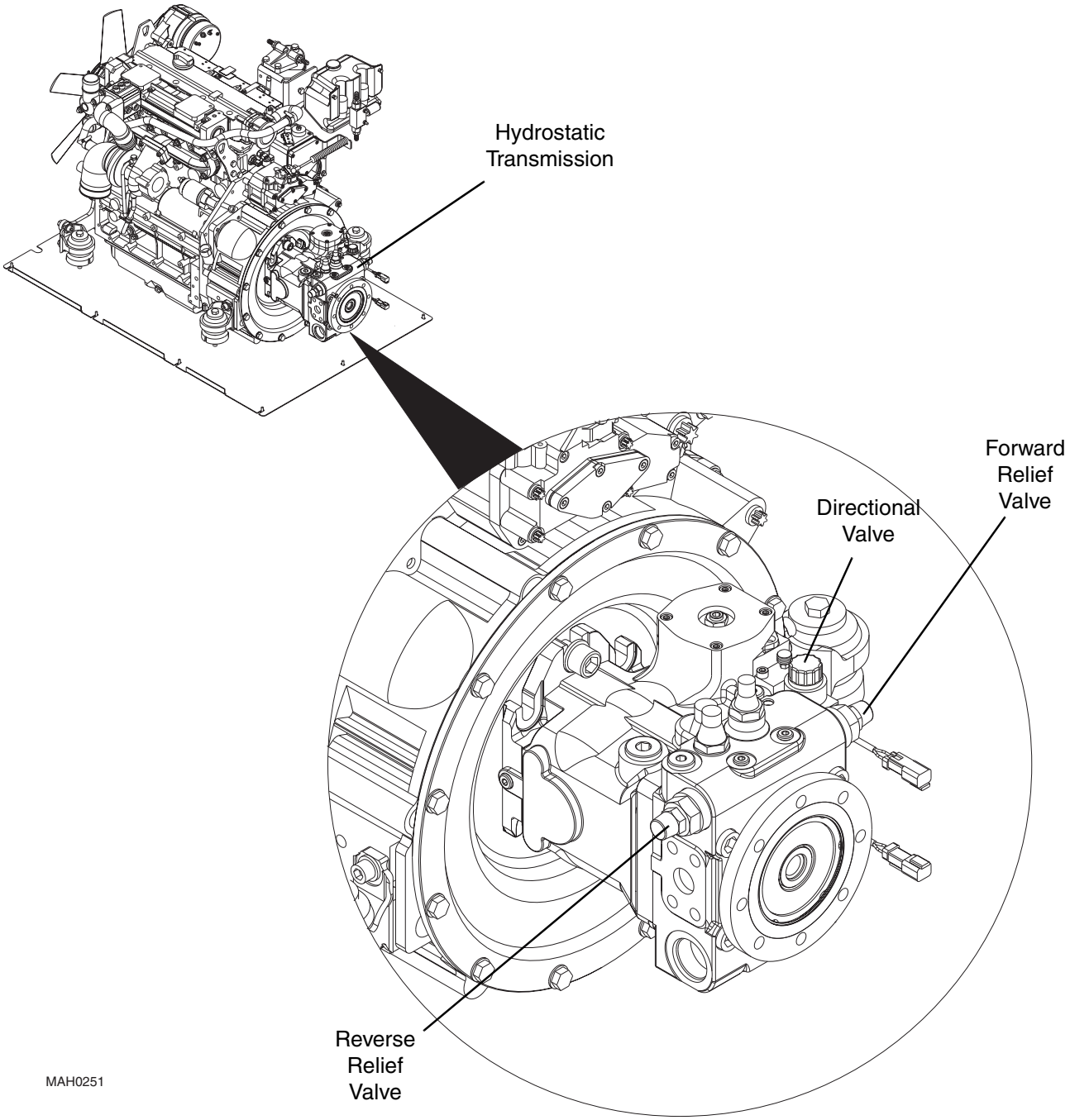
6.1 TRANSMISSION ASSEMBLY COMPONENT TERMINOLOGY

To understand the safety, operation and maintenance information presented in this section, it is necessary that the operator/mechanic be familiar with the names and locations of the major assemblies of the transmission. The following illustration identifies the components that are referred to throughout this section.



WARNING: **DO NOT** service the machine without following all safety precautions as outlined in Section 1, “Safety Practices,” of this manual. Failure to follow the safety practices may result in death or serious injury.

6.2 TRANSMISSION DESCRIPTION

Instructions in this section pertain mainly to general specifications, towing, maintenance information, and transmission removal and installation procedures. For internal transmission service instructions and detailed specifications contact your local JLG distributor for a copy of the Rexroth Repair Manual (P/N 31200124).

More information can be obtained from the serial number plate directly mounted on the transmission. Information specified on the serial number plate includes the transmission model number, the transmission serial number and other data. Information on the serial number plate is required in correspondence regarding the transmission.

6.3 TRANSMISSION SPECIFICATIONS

6.3.1 Transmission Maintenance

The transmission is a hydraulic component and requires the same maintenance as the hydraulic system. Refer to Section 2.5, “Maintenance Schedules.”

Performance criteria is based on full throttle engine speed unless otherwise specified or not applicable.

Travel Speed (no load)

G5-19A (with 405/70-20 tires)

First gear ..... 6 mph (10 km/hr)

Second gear ..... 21 mph (34 km/hr)

G6-23A (with 405/70-24 tires)

First gear ..... 4 mph (7 km/hr)

Second gear ..... 20 mph (33 km/hr)

6.4 TRANSMISSION REPLACEMENT

Note: *Contact your local **JLG** distributor if internal transmission repair is required during the warranty period.*

IMPORTANT: *To help ensure safety and optimum performance, replace the transmission if it is damaged. Refer to the appropriate parts manual for ordering information.*

Cleanliness is of extreme importance. Before attempting to remove the transmission, thoroughly clean the exterior of the transmission to help prevent dirt from entering during the replacement process. Avoid spraying water or cleaning solution onto or near the transmission shift solenoids and other electrical components.

6.4.1 Transmission Removal

1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, turn rear wheels to give easier access to rear of engine compartment, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Disconnect the battery negative (-) cable at the battery negative (-) terminal.
5. Remove battery from engine compartment, disconnect and remove battery tray.
6. Remove access panel in rear of engine compartment.
7. Remove belly pan of engine compartment.
8. Drain the hydraulic oil reservoir. Refer to Section 8.7.1, “Hydraulic Oil Reservoir Draining.”
9. Label, disconnect and cap all hydraulic hoses attached to transmission, cap all fittings and openings to keep dirt & debris from entering hydraulic system.
10. Label and disconnect all electrical connections attached to the transmission.
11. Wipe up any spilled hydraulic and transmission oil.
12. Vertically secure transmission with a lifting strap or chain. Use a suitable hoist or overhead crane. Operate the hoist or crane to remove slack from the

chain, but **DO NOT** raise the transmission at this time.

13. Remove the two Allen head bolts that attach the transmission to the engine.

WARNING: Risk of personal injury. The transmission may move while hoisting it out of the chassis. Carefully move the transmission and adjust the sling as needed. Keep fingers, hands, legs and other body parts clear of the transmission.

14. Carefully remove the transmission from the machine. Avoid causing damage to the transmission or surrounding parts.
15. Lift the transmission clear of the machine, and lower it onto suitable supports or secure it to a stand built especially for transmission or engine service. Secure the transmission so that it will not move or fall.

6.4.2 Transmission Disassembly

Transmission disassembly, internal inspection, service, repair and assembly procedures are covered in the Rexroth Repair Manual (P/N 31200124).

6.4.3 Transmission Installation

WARNING: Risk of severe personal injury. **NEVER** lift a transmission alone; enlist the help of at least one assistant or use a suitable hoist or overhead crane and sling.

1. Use a lifting strap or chain attached to a hoist or overhead crane to position the transmission within the chassis.
2. Insert the two Allen head bolts that attach the transmission to the engine. Torque to 154 lb-ft (210 Nm).
3. Remove the hoist or overhead crane and sling.
4. Uncap and reconnect the previously labeled hoses and electrical connections to their appropriate locations.
5. Fill hydraulic reservoir and bleed the system.
6. Reinstall the battery tray.
7. Replace battery into compartment and reconnect battery cables to terminals, starting with the positive (+) terminal.
8. Reattach access panel to rear of engine compartment.
9. Reinstall the belly pan.
10. Close and secure the engine cover.

6.4.4 After Transmission Replacement

1. Install new hydraulic filters.
2. Check the hydraulic oil level and add oil as required.

***IMPORTANT: DO NOT** use flushing compounds for cleaning purposes.*

3. Reassemble all components and fill the hydraulic reservoir with clean, fresh oil. **DO NOT** overfill.
4. Run the engine for two minutes at idle to help bleed any air from the hydraulic system.
5. Operate all boom functions to ensure any air is removed from the hydraulic system.
6. Retract and level the boom, recheck the level of the fluid in the reservoir.
7. Add oil as necessary to bring the fluid level up until it reaches the FULL mark on the reservoir. Recheck the oil level when it reaches operating temperature (180-200° F or 83-94° C).
8. Recheck all drain plugs, lines, connections, etc., for leaks, and tighten where necessary.

6.5 TOWING A DISABLED MACHINE

Towing a disabled machine should only be attempted as a last resort, after exhausting all other options. Make every effort to repair the machine, and move it under its own power.

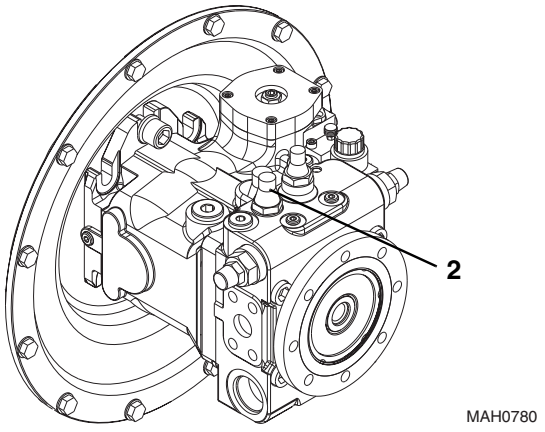
Towing is only possible by using the "towing" feature built into the hydrostatic pump and disengaging the park brake on the front axle.

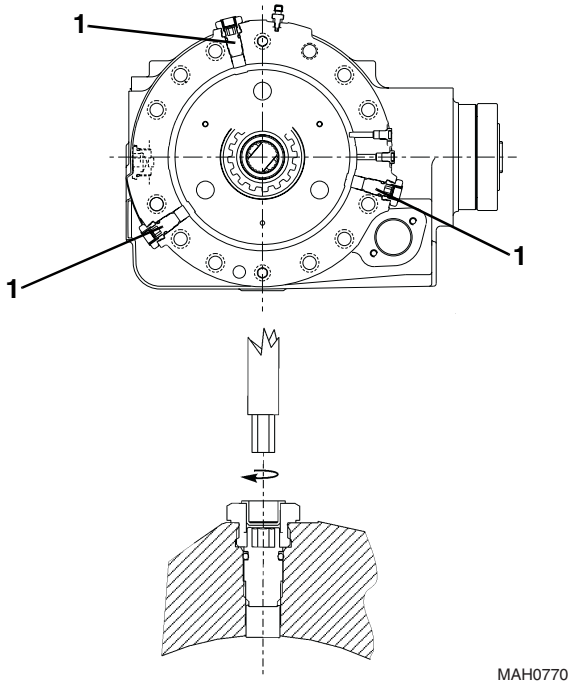
1. Securely block all four wheels.

WARNING: BLOCK ALL FOUR WHEELS. Failure to do so could result in death or serious injury from machine roll away.

2. Locate the six brake release bolts (**1**) at the base of the front axle. Mark a line on the socket so you can accurately count the number of turns each bolt makes as you perform the procedure.
3. Alternately screw the release bolts clockwise in 1/2 turn increments. Turn until resistance is felt.
4. Turn the tow option engagement screw (**2**) on the hydrostatic transmission counterclockwise three turns.
5. Carefully remove the blocking from each tire and tow the machine to a secure location.

Note: *This procedure does not alter any relief settings.*





After the machine has been towed to a secure location, reactivate the parking brake.

1. Block all four wheels.

WARNING: BLOCK ALL FOUR WHEELS. Failure to do so could result in death or serious injury from machine roll away.

2. Turn the tow option screw (**2**) on the hydrostatic transmission clockwise three turns.
3. Using a torque wrench, alternately unscrew the brake release bolts (**1**) outward in 1/2 turn increments until the torque drops off sharply.
4. Again, alternately unscrew the bolts outward until you feel the bolts flange begin to contact against the special screw.
5. Screw the bolts inward (clockwise) 1/4 turn.
6. The parking brake should now be reactivated and the front wheels locked.
7. Remove the blocks from the four tires.
8. Verify that the parking brake works.

Note: *If the parking brake does not work, check all activation operations step by step.*

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Section 7
Engine: Deutz BF 4M 2012

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7.1 INTRODUCTION

7.1.1 Disclaimer and Scope

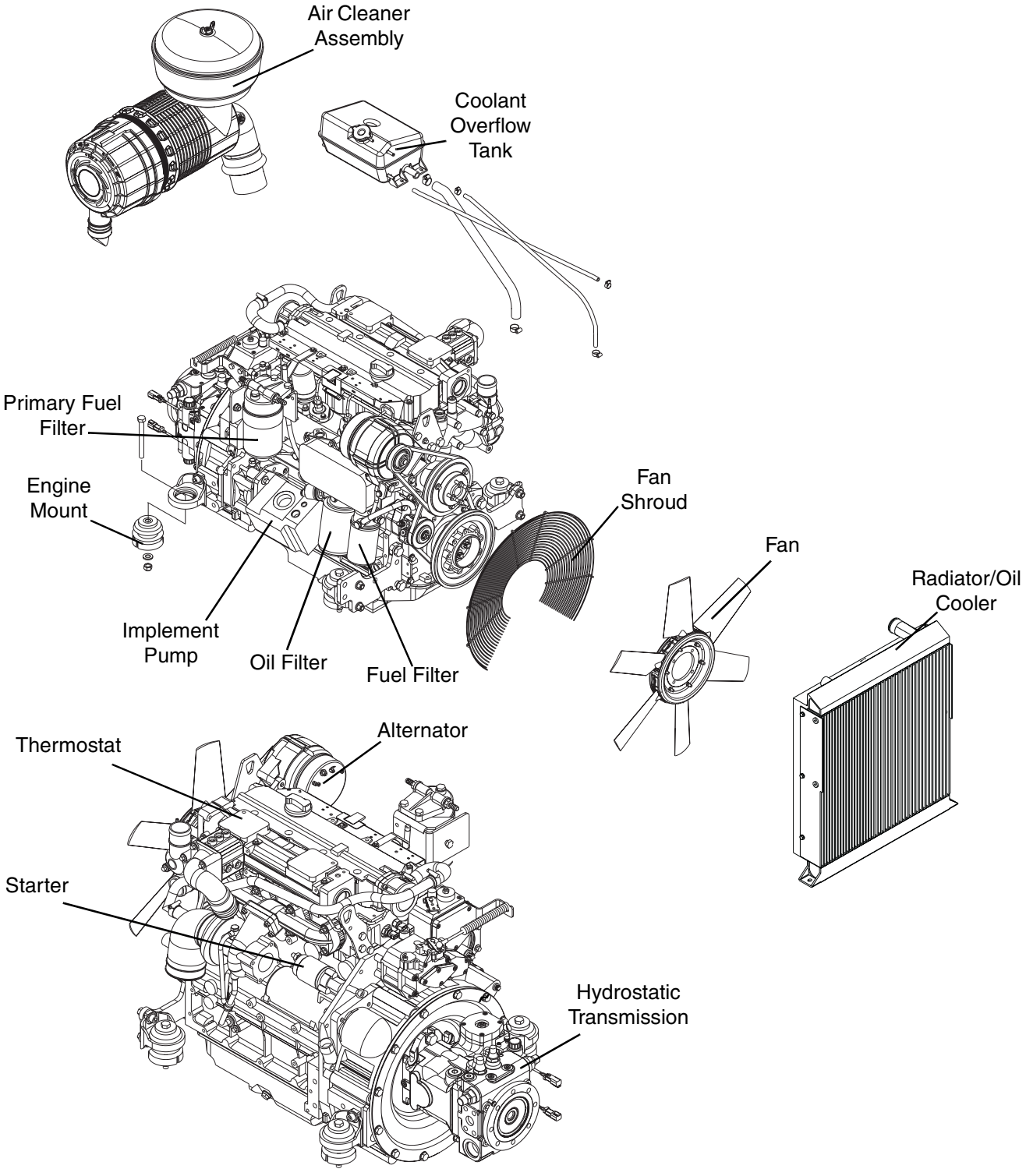
These instructions are written for worldwide use. In territories where legal requirements govern engine smoke emission, noise, safety factors, etc., apply all instructions, data and dimensions provided herein in such a way that after maintenance, service and repair of the engine, engine operation does not violate local regulations.

IMPORTANT: *These instructions cover only the routine maintenance, removal, installation and troubleshooting of the engine. For assistance with comprehensive engine diagnosis, repair and component replacement, contact your local Deutz AG Service partner.*

A gradual running-in (break-in) of a new engine is not necessary. Full load can be applied to a new engine as soon as the engine is put into service and the coolant temperature is at least 140° F (60° C). Extended light-load operation during the early life of the engine is not recommended. **DO NOT** run the engine at high, no-load speeds. **DO NOT** apply an overload to the engine.

7.1.2 Component Terminology

To understand the safety, operation and maintenance information presented in this section, it is necessary that the operator/mechanic be familiar with the names and locations of the engine components. The following illustration identifies the components that are referred to throughout this section.


Air Cleaner Assembly
Coolant Overflow Tank
Primary Fuel Filter
Engine Mount
Fan Shroud
Fan
Radiator/Oil Cooler
Implement Pump
Oil Filter
Fuel Filter
Alternator
Thermostat
Starter
Hydrostatic Transmission
MAH0230

7.2 ENGINE SERIAL NUMBER

The Deutz BF 4M 2012 serial number is located on a tag on top of the engine. Information contained in the serial number is required in correspondence with the engine manufacturer.

Supply the engine serial number and/or data tag information when communicating about an engine or engine components.

7.3 SPECIFICATIONS AND MAINTENANCE INFORMATION

For engine, coolant and oil specifications, and maintenance information, refer to Section 2, “General Information and Specifications.”

Note: *Detailed Deutz engine service instructions (covering disassembly, inspection, internal repair, assembly, adjustment and troubleshooting information) are provided in the appropriate Deutz engine service manual.*

7.4 ENGINE COOLING SYSTEM

7.4.1 Radiator Pressure Cap

For a 230° F (110° C) system, use a 13 psi (95 kPa) radiator cap. An incorrect or malfunctioning cap can result in the loss of coolant and a hot-running engine.

7.4.2 Radiator/Oil Cooler and Coolant Heater Replacement

Before considering radiator or oil cooler replacement for other than obvious damage, conduct a cooling system pressure test check the coolant specific gravity, coolant level, fan belt tension and dash panel temperature indicator.

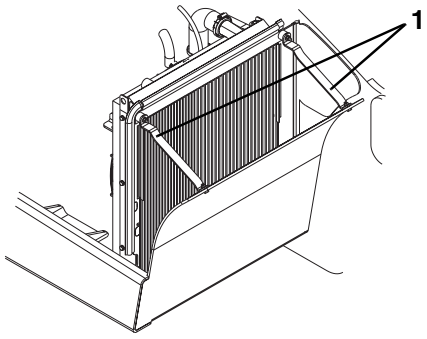
- If the engine runs hot, check the temperature of the upper radiator hose.
- If the hose is not hot, the thermostat may be stuck in the closed position.
- If the engine has overheated, performance may suffer, indicating other damage including a leaking cylinder head gasket, cracked cylinder head or block, and/or other internal engine damage.

a. Radiator/Oil Cooler Removal

1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Remove belly pan of engine compartment.
5. Thoroughly clean the engine and surrounding area, including all hoses and fittings before proceeding.
6. Disconnect the battery negative (-) cable from the battery negative (-) terminal.
7. Slowly turn the coolant overflow bottle cap and allow any pressure to escape. Remove the overflow bottle cap.
8. Place a suitable container beneath the radiator petcock.
9. Place a funnel at the base of the radiator to channel the drained coolant into the container. Open the radiator petcock and drain the coolant into the funnel. Transfer the fluid into a properly labeled

container. Dispose of properly if coolant needs to be replaced. Close the radiator petcock.

10. Label, disconnect and cap all coolant hoses attached to the radiator. Cap all fittings and openings to keep dirt & debris from entering the cooling system.
11. Label, disconnect and cap all hydraulic hoses attached to the radiator. Cap all fittings and openings to keep dirt & debris from entering the hydraulic system.
12. Detach the fan safety shroud.



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13. Remove the two brackets (**1**) at the front of the radiator attached to the frame.
14. Remove the locknuts holding the isolator mounts at the bottom of the machine.
15. Connect a lifting strap to the radiator/oil cooler and carefully lift the radiator/oil cooler out of the engine bay.

b. Radiator/Oil Cooler Installation

1. Install the isolator mounts to the bottom of the radiator. Insert radiator through the machine frame and secure to the radiator mount plate with new locknuts.
2. Be sure the engine fan has clearance in regard to the radiator. Install the two brackets (**1**) on the front of the radiator to the frame.
3. Attach the fan safety shroud.
4. Uncap and reconnect the previously labeled hydraulic hoses to the appropriate locations.
5. Uncap and reconnect all previously labeled coolant hoses to the appropriate locations.
6. Fill the coolant overflow bottle with a 50/50 mixture of ethylene glycol and water.
7. Connect the battery negative (-) cable to the battery negative (-) terminal.
8. Run the engine to operating temperature. Visually check for leaks with the engine running. Check the coolant level in the overflow bottle and fill, or drain, as necessary. Check the hydraulic fluid level in the tank and add fluid as required.
9. Attach the belly pan of the engine compartment.
10. Close and secure the engine cover.

7.5 ENGINE ELECTRICAL SYSTEM

The engine electrical system, including the starter, alternator and primary wiring, is described in Section 9, “Electrical System.”

7.6 FUEL SYSTEM

7.6.1 Diesel Fuel

Fuel represents a major portion of machine operating costs and therefore must be used efficiently. ALWAYS use a premium brand of high-quality, clean diesel fuel. Low cost, inferior fuel can lead to poor performance and expensive engine repair.

Note: *Use only diesel fuel designed for diesel engines. Some heating fuels contain harmful chemicals that can seriously affect engine efficiency and performance.*

IMPORTANT: *Due to the precise tolerances of diesel injection systems, keep the fuel clean, and free of dirt and water. Dirt and water in the fuel system can cause severe damage to both the injection pump and the injection nozzles. Use ASTM #2 diesel fuel with a minimum Cetane rating of 40. #2 diesel fuel gives the*

best economy and performance under most operating conditions. Fuels with Cetane numbers higher than 40 may be needed in high altitudes or extremely low ambient temperatures to help prevent misfiring and excessive smoking.

Inform the owner/operator of the machine to use #2 diesel fuel, unless ambient temperatures are below 32° F (0° C). When temperatures are below 32° F (0° C), a blend of #1 diesel and #2 diesel fuels (known as "winterized" #2 diesel) may be used.

Note: *#1 diesel fuel may be used, however, fuel economy will be reduced.*

WARNING: **DO NOT** mix gasoline or alcohol with diesel fuel. The mixture can cause an explosion.

Use a low-sulfur content fuel with a cloud point (the temperature at which wax crystals form in diesel fuel) at least 10° below the lowest expected fuel temperature. The viscosity of the fuel must be kept above 1.3 centistrokes to provide adequate fuel system lubrication.

Note: *When using diesel fuel with a sulfur content below 1.3 percent, the filter change interval must be reduced by 75 hours. The use of fuel with a sulfur content above 1.3 percent is not recommended.*

7.6.2 Fuel/Hydraulic Oil Tank

a. Cleaning and Drying

If contaminated fuel, hydraulic oil or foreign material is in the tank, the tank can usually be cleaned.

b. If a leak is suspected between the fuel and hydraulic oil tank, contact your local **JLG** distributor.

To clean the fuel/hydraulic oil tank:

1. Have a dry chemical (Class B) fire extinguisher near the work area.
2. Depending on which side of the tank is contaminated (fuel or hydraulic oil), remove the fuel or oil tank drain plug, and safely drain any fuel or hydraulic oil into a suitable container. Dispose of fuel or hydraulic oil properly.
3. Clean the fuel/hydraulic oil tank with a high-pressure washer, or flush the tank with hot water for five minutes and drain the water. Dispose of contaminated water properly.
4. For the fuel tank side, add a diesel fuel emulsifying agent to the tank. Refer to the manufacturer's instructions for the correct emulsifying agent-to-water mixture ratio. Refill the tank with water, and agitate the mixture for 10 minutes. Drain the tank completely. Dispose of contaminated water properly.
5. Refill the fuel tank with water until it overflows. Completely flush the tank with water. Empty the fuel tank, and allow it to dry completely.

c. Inspection

Note: *If a leak is suspected between the fuel and hydraulic oil tank, contact your local **JLG** distributor.*

1. Inspect the fuel/hydraulic oil tank thoroughly for any cracks, slices, leaks or other damage.
2. Plug all openings except one elbow fitting. Install the elbow fitting, and apply approximately 0.07-0.10 bar (1-1.5 psi) of air pressure through the elbow. Check the tank for leaks by applying a soap solution to the exterior and look for bubbles to appear at the cracked or damaged area.

d. Disassembly and Assembly

The fuel/hydraulic oil reservoir is a one piece-unit integral to the chassis frame and cannot be disassembled.

7.6.3 After Fuel System Service

1. Drain and flush the fuel tank if it was contaminated.
2. Fill the fuel tank with fresh, clean diesel fuel as required.

Note: *If bleeding of the fuel system is required, contact your local Deutz AG Service Partner.*

7.7 ENGINE EXHAUST AND AIR CLEANER SYSTEM

WARNING: Exhaust fumes contain carbon monoxide, a colorless, odorless gas which is fatal when inhaled in a confined area. Avoid breathing exhaust fumes, and prevent engine operation from becoming a cause of toxic emissions. Exhaust system components reach high temperatures and can cause severe burns. **DO NOT** come into contact with hot exhaust system components.

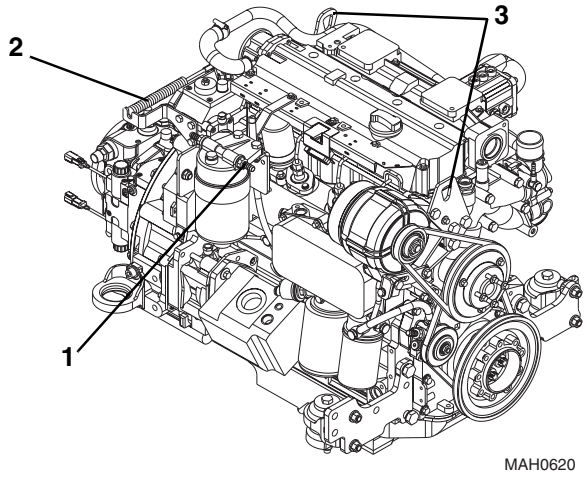
When the exhaust or air cleaner systems are removed be sure to cover any open ports to prevent dirt and debris from contaminating engine components.

CAUTION: **NEVER** run the engine with only the inner safety element installed.

7.8 ENGINE REPLACEMENT

7.8.1 Engine Removal

1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Remove belly pan of engine compartment.
5. Thoroughly clean the engine and surrounding area, including all hoses and fittings before proceeding.
6. Disconnect the battery negative (-) cable from the battery negative (-) terminal.
7. Remove the engine cover.
8. Remove battery from engine compartment, disconnect and remove battery tray.
9. Drain hydraulic reservoir. Refer to Section 8.7.1, “Hydraulic Oil Reservoir Draining.”
10. Drain radiator and overflow bottle. Refer to Section 7.4.2, “Radiator/Oil Cooler and Coolant Heater Replacement.”
11. Label, disconnect and cap all hydraulic hoses attached to engine and radiator, cap all fittings and plug hoses to keep dirt & debris from entering hydraulic system.
12. Disconnect the fuel inlet (**1**) and return lines. Install a plug in the end of each line.
13. Remove hydraulic and fuel filters, windshield washer fluid reservoir and filter bracket assembly.
14. Remove radiator overflow bottle.
15. Unbolt and remove the fan safety shroud.
16. Remove bolts securing the radiator and lift it clear of engine compartment. Refer to section Section 7.4.2, “Radiator/Oil Cooler and Coolant Heater Replacement.”.
17. Mark the engine fan orientation. Remove the engine fan.



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18. Unbolt the relay distribution panel behind the engine. Label any loose wire connections.
19. Unplug the necessary harness plugs that go into the cab.
20. Carefully pull wires through engine compartment wall and place on engine.
21. Mark the location of the throttle cable (**2**) at the engine throttle lever. Disconnect the throttle cable.
22. Detach exhaust and air cleaner hoses from the engine. Cover air inlets to protect from dirt & debris.
23. Remove air cleaner assembly from engine compartment.
24. Completely disconnect exhaust pipe.
25. Remove the hydraulic reservoir fill tube.
26. Secure the engine with a lifting strap or chain from the appropriate lifting points (**3**). Use a suitable hoist or overhead crane.
27. Remove the 4 motor mount bolts that attach the engine to the frame.
28. Carefully lift the engine from the machine. Avoid causing damage to the surrounding parts.
29. Lift the engine clear of the machine, and lower it onto suitable supports or stand. Secure the engine so that it will not move or fall.

7.8.2 Engine Disassembly, Inspection and Service

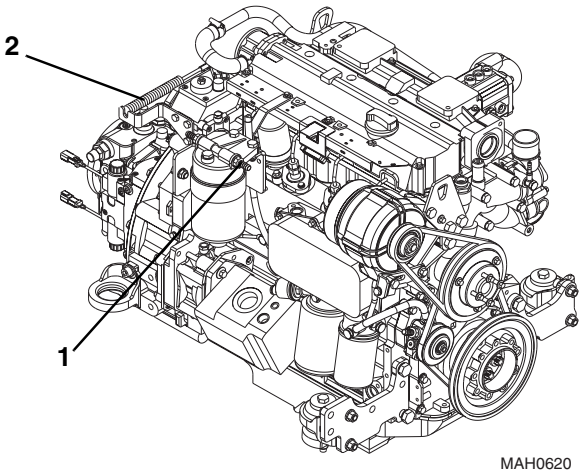
Engine disassembly, internal inspection, service, repair and assembly procedures are covered in the Deutz BF 4M 2012 service manual. Several special engine service tools are required to properly service the Deutz engine. Contact your local Deutz AG Service partner for further information.

Note: *If the engine is being replaced, there may be external components that will be required to be transferred from the original engine to the replacement engine depending upon who you purchase the new engine from and the configuration of your replacement engine. Refer to the appropriate Deutz user manual for detailed procedures that cover the transfer of original engine components to the replacement engine.*

7.8.3 Engine Installation

Note: *Refer to Section 2.2, "Torques," for specific fastener torque specifications.*

1. Position engine in engine compartment being sure to line up the 4 motor mount holes. Replace bolts and torque to 71 lb-ft (97 Nm).
2. Connect the hydraulic reservoir fill tube.
3. Connect the exhaust pipe to the engine.
4. Install the air cleaner assembly into the engine compartment and attach hose to air intake.
5. Reconnect throttle cable (**2**) onto the engine, if necessary adjust for full travel.
6. Feed engine harness wires through the engine compartment wall and plug into the ports located on the side of the cab.
7. Reattach the relay distribution panel and connect any loose wires.
8. Install the overflow bottle bracket and secure the expansion tank.
9. Attach the engine fan.
10. Secure the radiator with the necessary bolts and attach the fan safety shroud. Check that the fan top clearance is adequate with regard to the radiator. Reattach the previously labeled hoses. Refer to Section 7.4.2, "Radiator/Oil Cooler and Coolant Heater Replacement." Fill with a 50/50 mixture of ethylene glycol and water.
11. Install the filter bracket assembly. Secure the hydraulic and fuel filters and windshield washer fluid reservoir.
12. Connect the fuel inlet line to the fuel filter (**1**) and reconnect the return fuel line to the engine.
13. Uncap and reconnect all hydraulic hoses and fittings to the engine and necessary hydraulic elements. Keep hoses free of dirt & debris.
14. Refill the hydraulic reservoir (Refer to the appropriate Operation & Safety Manual for information concerning the hydraulic oil and filter change).



15. Replace the battery tray and battery and reconnect the battery terminals, being sure to start with the positive (+) terminal.
16. Check that all hydraulic, electrical, cooling, fuel and exhaust system connections are correct and connected tightly.
17. Run engine to normal operating temperature then shut off the engine. While the engine is cooling, check for leaks.
18. Allow the engine to cool. Check the radiator coolant level, and top off with a 50/50 mixture of ethylene glycol and water. Replace the radiator cap.
19. Check for leaks from the engine, main hydraulic pump and lines, transmission, hydraulic reservoir and fuel tank. Check the levels of all fluids and lubricants. Fill as required.

IMPORTANT: *During the full throttle check:*

- ***DO NOT*** *operate any hydraulic function.*
- ***DO NOT*** *steer or apply any pressure to the steering wheel.*
- *Keep the transmission in NEUTRAL (N).*

20. Obtain and connect an appropriate engine analyzer or tachometer. Check the engine rpm at full throttle.

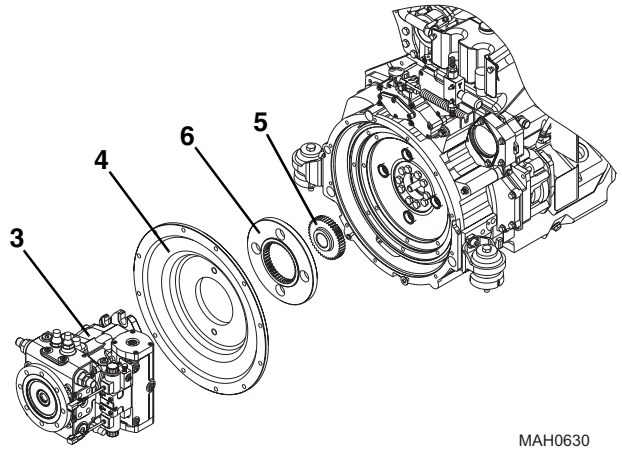
If the rpm is not 2370 ±50 rpm, readjust the throttle limit-stop screw at the throttle pedal within the cab.

21. Purge the hydraulic system of air by operating all boom functions through their entire range of motion several times. Check the hydraulic oil level.
22. Check for proper operation of all components.
23. Turn the engine OFF.
24. Install the belly pan.
25. Install the engine cover. Close and secure the cover.

7.9 ENGINE COUPLER

7.9.1 Coupler Removal

1. Remove Hydrostatic transmission (**3**). Refer to Section 6.4.1, “Transmission Removal.” Be sure to follow all described safety guidelines.
2. After transmission has been removed, take out the 12 bolts that attach the Flywheel Cover Plate (**4**) to the engine.
3. Pull off the Flywheel Cover Plate to expose the coupler (**5**) and the flywheel.
4. Remove the necessary bolts to detach the coupler and flex plate (**6**).



7.9.2 Coupler Installation

1. Attach the coupler (**5**) and flex plate (**6**) using the necessary bolts. Torque to 155 lb-ft (210 Nm).
2. Bolt on the Flywheel Cover Plate (**4**) over the coupler and flywheel. Torque bolts to 37 lb-ft (50 Nm).
3. Reattach the hydrostatic transmission (**3**). Follow all guidelines in Section 6.4.3, “Transmission Installation.”

7.10 TROUBLESHOOTING

Trouble	Possible Causes (see key, below)
Low Cranking Power	1, 2, 3, 4
Will Not Start	5, 6, 7, 8, 9, 10, 12, 13, 14, 17, 18, 19, 20, 22, 31, 32, 33
Difficult Starting	5, 7, 8, 9, 10, 11, 12, 13, 14, 16, 18, 19, 20, 21, 22, 24, 29, 31, 32, 33
Lack of Power	8, 9, 10, 11, 12, 13, 14, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 31, 32, 33
Misfiring	8, 9, 10, 12, 13, 14, 18, 19, 20, 25, 26, 28, 29, 30, 32
Excessive Fuel Consumption	11, 13, 14, 16, 18, 19, 20, 22, 23, 24, 25, 27, 28, 29, 31, 32, 33
Black Exhaust	11, 13, 14, 16, 18, 19, 20, 22, 24, 25, 27, 28, 29, 31, 32, 33
Blue/White Exhaust	4, 18, 19, 20, 25, 27, 31, 33, 34, 35, 45, 56
Low Oil Pressure	4, 36, 37, 38, 39, 40, 42, 43, 44, 58
Knocking	9, 14, 18, 19, 22, 26, 28, 29, 31, 33, 35, 36, 45, 46, 59
Erratic Running	7, 8, 9, 10, 11, 12, 13, 14, 20, 21, 23, 26, 28, 29, 30, 33, 35, 45, 59
Vibration	13, 14, 20, 23, 25, 26, 29, 30, 33, 45, 47, 48, 49
High Oil Pressure	4, 38, 41
Overheating	11, 13, 14, 18, 19, 24, 25, 45, 50, 51, 52, 53, 54, 57
Excessive Crankcase Pressure	15, 25, 31, 33, 34, 45, 55
Poor Compression	11, 19, 25, 28, 29, 31, 32, 33, 34, 46, 59
Starts and Stops	10, 11, 12

Key to Possible Causes

1. Battery charge low
2. Bad electrical connection
3. Faulty starter motor
4. Incorrect grade of lubricating oil
5. Low cranking speed
6. Fuel tank empty
7. Faulty stop control operation
8. Fuel inlet restricted
9. Faulty fuel lift pump
10. Clogged fuel filter
11. Restricted air cleaner
12. Air in fuel system
13. Faulty fuel injection pump
14. Faulty fuel injectors or incorrect type
15. Exhauster or vacuum pipe leak
16. Induction system leaks
17. Broken fuel injection pump drive
18. Incorrect fuel pump timing
19. Incorrect valve timing
20. Poor compression
21. Blocked fuel tank vent
22. Incorrect grade of fuel
23. Sticking throttle or restricted movement
24. Exhaust pipe restriction
25. Leaking cylinder head gasket
26. Overheating
27. Cold running
28. Incorrect tappet adjustment
29. Sticking valves
30. Incorrect high pressure pipes
31. Worn cylinder bores
32. Pitted valves and seats
33. Broken, worn or sticking piston ring(s)
34. Worn valve stems and guides
35. Restricted air cleaner
36. Worn or damaged bearings
37. Insufficient oil in sump
38. Inaccurate gauge
39. Oil pump worn
40. Pressure relief valve sticking open
41. Pressure relief valve sticking closed
42. Broken relief valve spring
43. Faulty suction pipe
44. Restricted oil filter
45. Piston seizure/pick up
46. Incorrect piston height
47. Damaged fan
48. Faulty engine mounting
49. Incorrectly aligned flywheel housing or incorrectly aligned flywheel
50. Faulty thermostat
51. Restriction in water jacket
52. Loose fan belt
53. Restricted radiator
54. Faulty water pump
55. Restricted breather pipe
56. Damaged valve stem oil deflectors (if fitted)
57. Coolant level too low
58. Blocked sump strainer
59. Broken valve spring

Section 8
Hydraulic System

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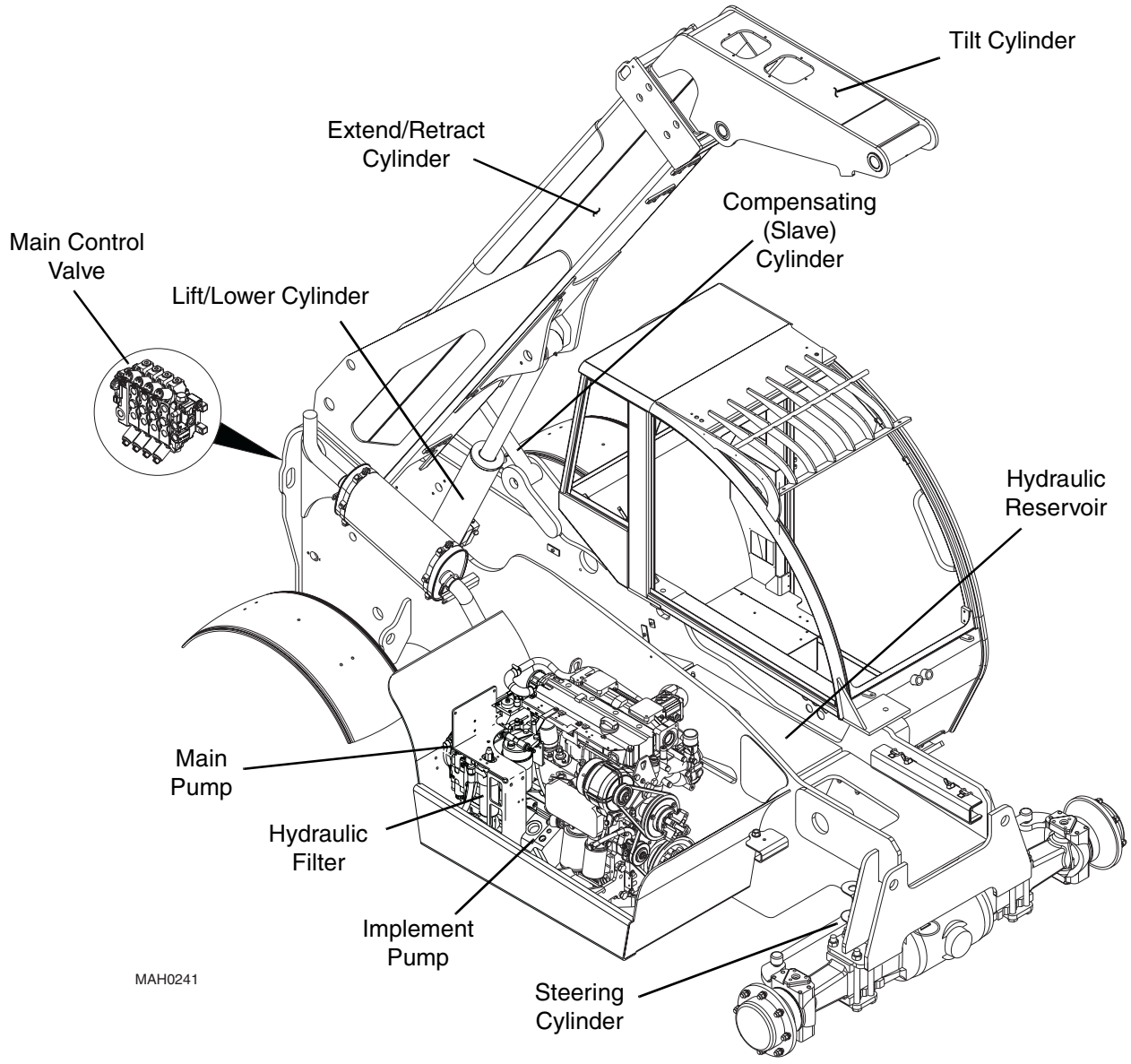
8.1 HYDRAULIC COMPONENT TERMINOLOGY

To understand the safety, operation and service information presented in this section, it is necessary that the operator/mechanic be familiar with the name and location of the hydraulic components of the machine. The following illustration identifies the components that are referred to throughout this section.



8.2 SAFETY INFORMATION

WARNING: **DO NOT** service the machine without following all safety precautions as outlined in Section 1, “Safety Practices,” of this manual. Failure to follow the safety practices may result in death or serious injury.

Petroleum-based hydraulic fluids are used in this machine. The temperature of hydraulic fluid increases during the operation of various hydraulic functions. A heated petroleum-based hydraulic fluid presents a fire hazard, especially when an ignition source is present.

Accordingly, periodically inspect all hydraulic system components, hoses, tubes, lines, fittings, etc. Carefully examine any deterioration and determine whether any further use of the component would constitute a hazard. If in doubt, replace the component.

Whenever you disconnect a hydraulic line, coupler, fitting or other component, slowly and cautiously loosen the part involved. A hissing sound or slow seepage of hydraulic fluid may occur in most cases. After the hissing sound has ceased, continue removing the part. Any escaping oil should be directed into an appropriate container. Cap or otherwise block off the part to prevent further fluid seepage.

Hydraulic system maintenance will, at times, require that the engine be operated. Always follow safety precautions.

A major cause of hydraulic component failure is contamination. Keeping the hydraulic fluid as clean as possible will help avoid downtime and repairs. Sand, grit and other contaminants can damage the finely machined surfaces within hydraulic components. If operating in an exceptionally dirty environment, change filters and inspect the fluid more often. When servicing the system, cap or plug hydraulic fittings, hoses and tube assemblies. Plug all cylinder ports, valves and the hydraulic reservoir, and pump openings until installation occurs. Protect threads from contamination and damage.

Some hydraulic functions are actuated by interfacing with electrical system components (switches, solenoids and sensors). When the hydraulic system is not functioning properly, check the electrical aspect of the malfunctioning circuit also.

8.3 SPECIFICATIONS

Refer to Section 2.3, “Specifications,” for hydraulic system specifications.

8.4 HOSES, TUBE LINES, FITTINGS, ETC.

There are numerous hydraulic hoses, tubes, fittings, etc. used on this machine. Periodically inspect all of these and carefully examine any signs of wear, abrasion and/or deterioration. Determine whether any further use of the component would constitute a hazard. If in doubt, replace the component.

8.4.1 Replacement Considerations

Conditions including, but not limited to, the following are sufficient for considering component replacement:

1. Any evidence of hydraulic fluid leakage at the surface of a flexible hose or its junction with the metal and couplings.
2. Any blistering or abnormal deformation to the outer covering of a hydraulic hose.
3. Hydraulic oil leakage at any threaded or clamped joint that cannot be eliminated by normal tightening or other recommended procedures.
4. Evidence of excessive abrasion or scrubbing on the outer surface of a hose, rigid tube, or hydraulic fitting. Modification must be made to eliminate the interference of the elements in contact with one another, or to otherwise protect the components from contact with one another. Slightly moving a hose or adjusting a plastic tie wrap may often be all that is necessary to eliminate interference; evaluate each situation and proceed as required by the individual circumstances.

8.4.2 Hose, Tube, Line and Fitting Replacement

Before removing a hydraulic hose or component, always mark or otherwise label the related parts and the exact location of the hose or component to aid in proper reinstallation. Hydraulic fluid is a good cleaner and can remove most liquid-ink type markings, so make sure the mark or label will remain intact. Alternative methods to using markers include color-coded tie wraps, number-tag sets, alpha-numeric stampings or markings, and suitably labeled pieces of tape. Select an appropriate marking method for the conditions and proceed accordingly.

NEVER replace a hydraulic hose or other component with a part not specifically designed for this machine. Use only factory approved parts for best performance and safety.

Removal and replacement of hoses, tube lines, fittings, etc. usually involves straightforward procedures. When removing a hydraulic hose or other component, be aware that o-rings are used throughout the hydraulic system.

ALWAYS replace a used o-ring with a new part.

Check all routing of hoses, wiring and tubing for sharp bends or interference with any rotating members. Install appropriate protective devices such as tie wraps and conduit to help shield hoses from damage. All tube and hose clamps must be tight.

8.5 HYDRAULIC PRESSURE DIAGNOSIS

JLG Parts Department has a kit available to use for hydraulic system maintenance and troubleshooting: the JLG Pressure Test Kit. The kit is in a durable polyethylene carrying case for demanding field service conditions.

Pressure Test Kit

The hydraulic pressure test kit is used to pressure test the various hydraulic components in the hydraulic system. The kit includes:

- Gauges for testing high and low pressure circuits
- Fittings, couplers and hoses
- Durable carrying case

Contact your local **JLG** distributor for ordering information.

Part Number	Description	Approximate Weight	Price and Availability
80904003	Hydraulic Pressure Test Kit	10 lbs.	Consult Factory

8.5.1 Pressure Checks and Adjustments

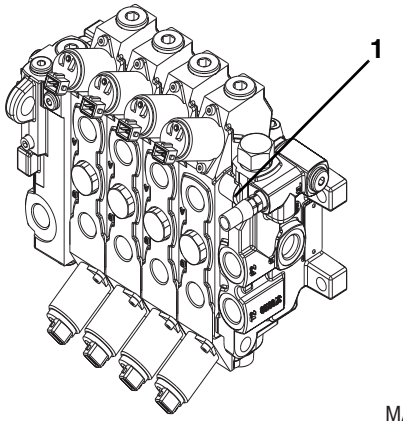
In general, follow the steps below whenever conducting pressure checks and performing adjustments:

1. Park the machine on a firm, level surface. Engage the park brake, place the transmission control lever in (N) NEUTRAL, place the neutral lock lever in the (N) NEUTRAL LOCK position, level the boom and turn the engine OFF.
2. Pressure tee fittings are conveniently located in each hydraulic circuit. Install a pressure gauge capable of measuring at least 10% more pressure than that which the circuit being checked operates under.
3. Start the engine. Operate machine functions several times to allow hydraulic oil to reach operating temperature. The hydraulic oil temperature should be between 100-120° F (38-49° C). If a temperature gauge or thermometer is unavailable, the hydraulic oil reservoir should be warm to the touch.
4. Fully depress the accelerator pedal as required. Place and hold the joystick in the position needed to operate the particular machine function being checked. Continue holding the joystick in position until pressure readings are taken.
5. Check the pressure gauge reading. It should read as described in the appropriate section. If the reading is not as specified, turn the engine OFF and check other components in the system. Verify that all related hydraulic components and electrical switches, sensors, solenoids, etc. are operating correctly.
6. As a last resort, adjust the appropriate relief valve, if applicable. Turning the adjustment screw clockwise will increase the pressure; turning the screw counterclockwise will decrease the pressure.

Start the engine and check the pressure again. Turn the engine OFF, operate the auxiliary hydraulic control lever (on units equipped with the optional auxiliary hydraulic system), then disconnect or remove the pressure gauge from the machine.

8.5.2 Main Control Valve Pressure Checking

Attach 5000 psi (345 bar) gauge to the test port (**1**) on the main control valve port to check the system pressure. The main control valve pressure should be 3600 psi (250 ± 5 bar) at full throttle.

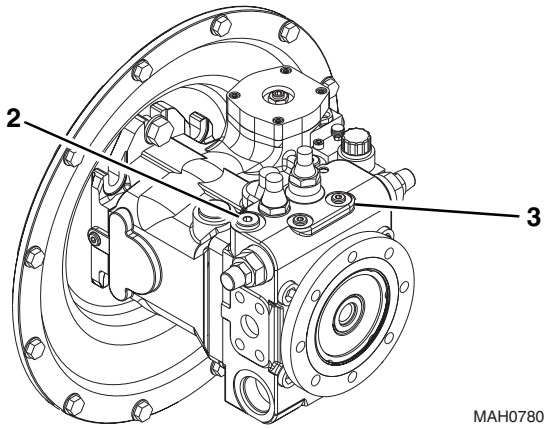


MAH0120

8.5.3 Charge Pressure Checking

Attach a pressure gauge to the test port (**2**) on the hydrostatic transmission to check the system pressure. The pressure should be 362 to 406 psi (25 to 28 bar) with the engine at idle.

Do **NOT** adjust any relief settings. The unit is preset at the factory and should not be tampered with. If the proper pressure is not read, the unit may be defective.



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8.5.4 Drive Pressure Checking

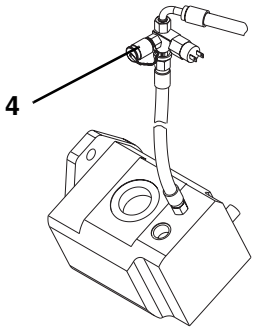
Attach a pressure gauge to the test fitting (**3**) on the hydrostatic transmission to check the system pressure. Check the drive pressure with the park brake on and the service brake off at full throttle. The pressure reading should be 6381 to 6671 psi (440 to 460 bar).

Do **NOT** adjust any relief settings. The unit is preset at the factory and should not be tampered with. If the proper pressure is not read, the unit may be defective.

8.5.5 Steering Pressure Checking

Attach a pressure gauge to the test fitting (**4**) on the appropriate hose of the implement pump. The pressure reading should be 2610 psi (180 bar) with the steering wheel fully turned to one direction.

Do **NOT** adjust any relief settings. The unit is preset at the factory and should not be tampered with. If the proper pressure is not read, the unit may be defective.



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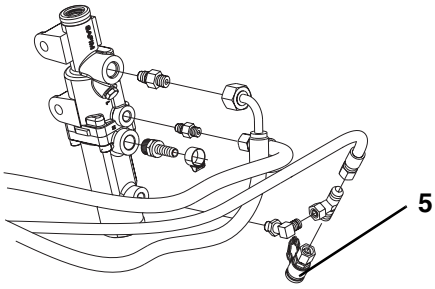
8.5.6 Brake Pressure Checking

Attach a pressure gauge to the test fitting (**5**) on the brake valve in the cab to check system pressure. The pressure reading should be 435 psi (30 bar) with the brake pedal fully depressed.

Do **NOT** adjust any relief settings. The unit is preset at the factory and should not be tampered with. If the proper pressure is not read, the unit may be defective.



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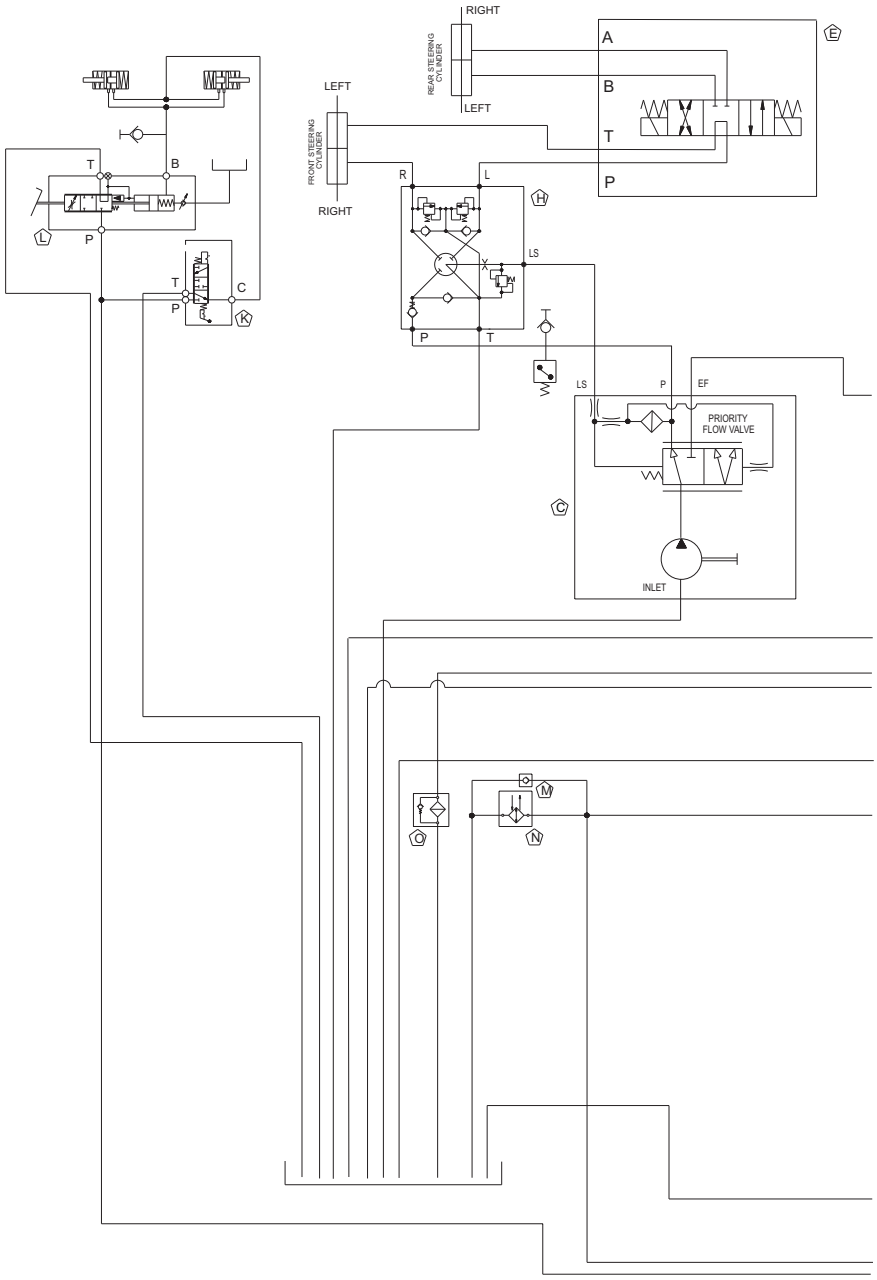
8.6 HYDRAULIC SCHEMATIC



ITEM	DESCRIPTION
A	PUMP, DRIVE
B1	MOTOR, DRIVE - G5-19A
B2	MOTOR, DRIVE - G6-23A
B3	MOTOR, DRIVE - G6-23A
C	PUMP, IMPLEMENT - WITH PRIORITY VALVE
D	FILTER, CHARGE - REMOTE MOUNT
E	VALVE, STEER SELECT
F	VALVE, MAIN CONTROL
G	VALVE, LOW RANGE
H	VALVE, STEERING
J	VALVE, FRONT/REAR AUX - OPTIONAL
K	VALVE, PARK BRAKE
L	VALVE, SERVICE BRAKE
M	VALVE, 3 BAR CHECK - COOLER BYPASS
N	COOLER, TRANSMISSION
O	FILTER, MAIN RETURN - TANK MOUNT
P	VALVE, 1ST/2ND FRONT AUX - OPTIONAL
Q	VALVE, TRAILER BRAKES - OPTIONAL
R	VALVE, BRAKE INCHING

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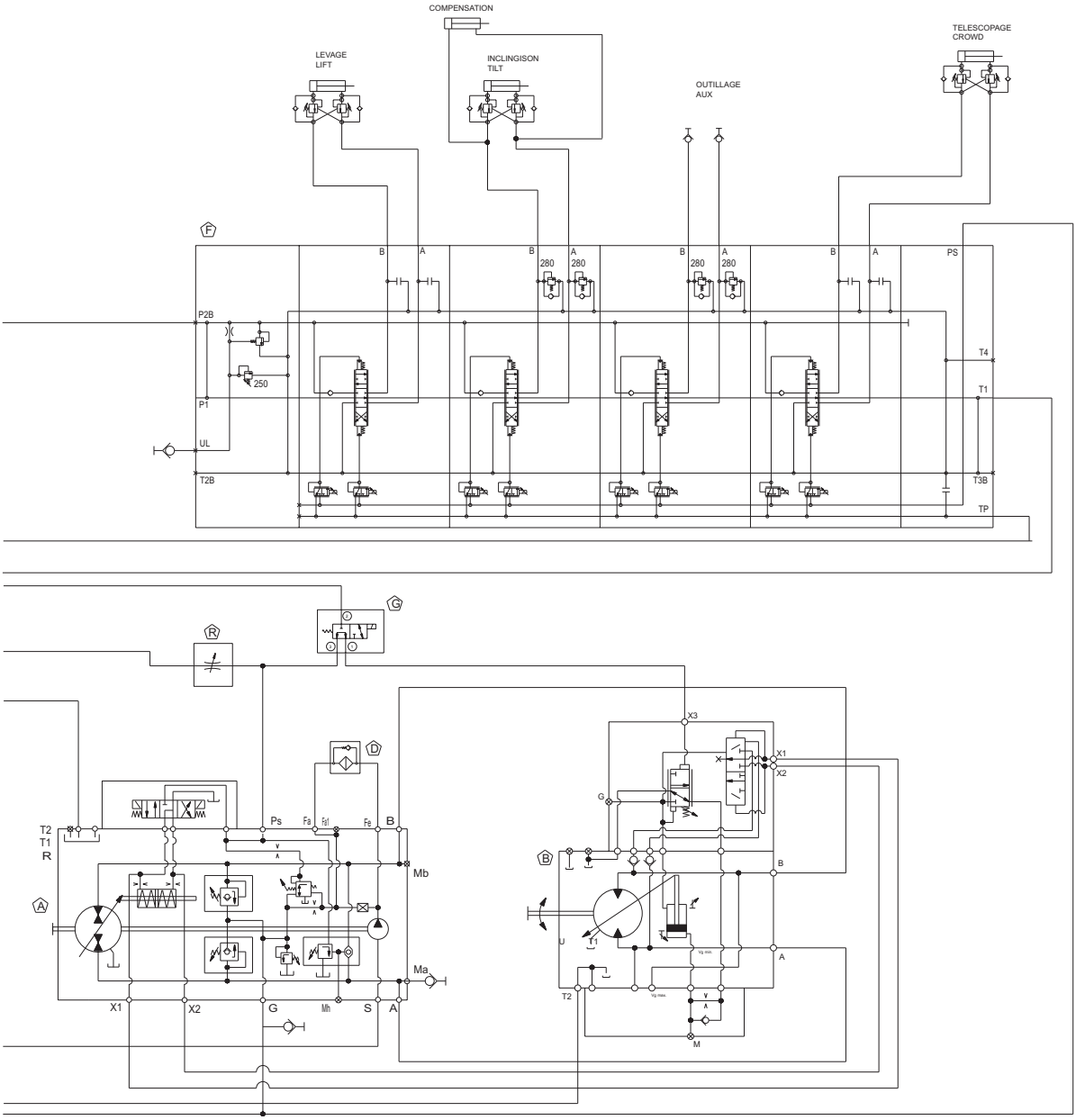

COMPENSATION
LEVAGE
LIFT
INCLINGISON
TILT
OUTILLAGE
AUX
TELESCOPAGE
CROWD
F
B
A
280
PS
P2B
250
P1
UL
T2B
T4
T1
T3B
TP
G
R
D
T2
T1
R
Ps
Fa
Frl
Fe
B
Mb
A
Ma
X1
X2
G
Mn
S
A
X3
X1
X2
G
B
B
A
U
T1
T2
M

MAH1160

8.7 HYDRAULIC RESERVOIR

The hydraulic reservoir and fuel tank are part of the frame. For this reason, neither tank can be removed. For cleaning instructions, see Section 7.6.2, “Fuel/Hydraulic Oil Tank.”

Occasionally, fluid may seep, leak or be more forcefully expelled from the filter head when system pressure exceeds the rating of the filter head or breather. If the return filter becomes plugged, return hydraulic oil will bypass the filter when pressure reaches 22 psi (1,5 bar) and return to the reservoir unfiltered.

Carefully examine fluid seepage or leaks from the hydraulic reservoir to determine the exact cause. Clean the reservoir and note where any seepage occurs.

Leaks from a cracked or damaged reservoir require that the reservoir be flushed completely with water and repaired by a certified welder using approved techniques. If these conditions cannot be met, the reservoir must be replaced in its entirety. Contact your local **JLG** distributor should reservoir welding be required.

8.7.1 Hydraulic Oil Reservoir Draining

1. Park the machine on a firm, level surface, fully retract the boom, support the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Remove the drain plug at the bottom of the hydraulic oil reservoir.
5. Transfer the used hydraulic oil into a suitable, covered container, and label as "Used Oil". Dispose of used oil at an approved recycling facility. Clean and reinstall the drain plug.
6. Wipe up any spilled hydraulic oil.

8.7.2 Hydraulic Oil Reservoir Filling

1. Be sure the reservoir is clean and free of all debris.
2. Install new hydraulic oil filters.
3. Fill the reservoir with Mobilfluid® 424 (ISO Grade 46) oil. Refer to Section 2.4, “Fluids, Lubricants and Capacities.”
4. Start the machine. Run engine to normal operating temperature. Operate all hydraulic functions.

8.8 HYDRAULIC SYSTEM PUMP

8.8.1 Implement Pump Failure Analysis

The implement pump is the “heart” of the hydraulic system, and whenever there is a problem in the system, the pump often is blamed. However, implement pump failure is seldom due to failure of pump components. Pump failure usually indicates another problem in the hydraulic system.

According to pump manufacturer statistics, 90-95 percent of pump failures are due to one or more of the following causes:

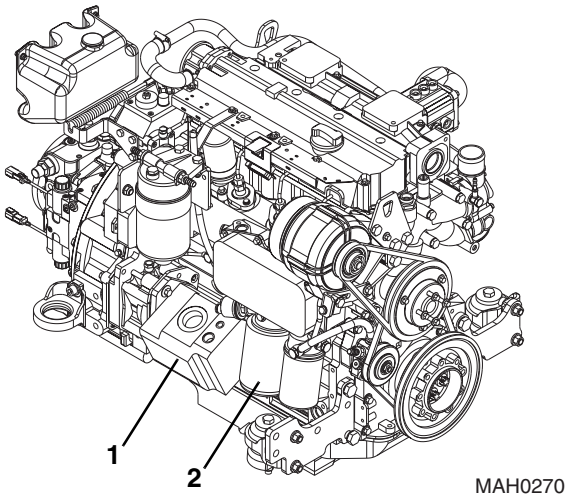
- Aeration
- Cavitation
- Contamination
- Excessive Heat
- Over-Pressurization
- Improper Fluid

In the event of pump failure, investigate further to determine the cause of the problem.

8.8.2 Implement Pump Replacement

a. Implement Pump Removal

1. Park the machine on a firm, level surface, fully retract the boom, support the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Drain the hydraulic oil reservoir. Refer to Section 8.7.1, “Hydraulic Oil Reservoir Draining.”
5. Remove the belly pan.



6. Thoroughly clean the pump (**1**) and surrounding area, including all hoses and fittings before proceeding.
7. Label, disconnect and cap all hydraulic hoses attached to the pump, cap all fittings and plug hoses to keep dirt & debris from entering the hydraulic system.
8. Remove the engine oil filter (**2**).
9. Remove the two bolts that hold the pump in place.

b. Implement Pump Disassembly

1. Mark the position of the body and flange to ensure correct reassembly
2. Remove the nuts and washers attaching the flange to the body. If necessary, carefully separate with a soft faced hammer.
3. Remove the retaining circlip and shaft seal from the flange.
4. Pull out the main shaft assembly. Mark the position of the drive gear and balance plate. Remove the drive gear and balance plate.
5. Discard all seals and clean off all sealant from the flange/body interface.

c. Implement Pump Cleaning

Clean all pump components with a suitable cleaner such as trichlorethylene.

d. Implement Pump Inspection

Inspect internal pump components for wear, damage, etc. If inner surfaces of the pump **DO NOT** display an ultra-smooth, polished finish, or are damaged in any way, replace the damaged part. Often, dirty hydraulic fluid causes failure of internal pump seals and damage to the polished surfaces within the pump and other hydraulic system components.

Inspect the o-ring groove and shaft seal recess in the mounting flange. Be sure they are undamaged and free from burrs.

The pump must be replaced if:

1. The PFE coated bearings in the body and flange are worn through revealing the bronze backing.
2. The gear side faces are scored.
3. There is a noticeable wear groove on the main shaft where the shaft seal lips run.
4. The bronze balance plates are scored.

Note: *It is not recommended that damaged gears/ bodies, flanges or balance plates are replaced individually as this will not constitute a good repair.*

Note: *ALWAYS replace seals, o-rings, gaskets, etc., with new parts to help ensure proper sealing and operation. Lubricate seals and o-rings with clean hydraulic oil.*

e. Implement Pump Assembly

Note: *Before assembly, all parts must be perfectly clean and lubricated with hydraulic fluid. Renew all seals using hydraulic fluid as a lubricant.*

1. Fit the shaft seal mounting flange with the garter spring facings into the pump and refit the circlip.
2. Fit the channel seals and back-up rings into grooves on balance plate into bore. Ensure that the seals remain in their groove and that the two small holes in the balance plate are to the low pressure side of the pump.
3. Insert the main shaft and drive gear into their original bores.
4. Replace the second balance plate into its original position. Be sure the small holes are to the low pressure side, fit the channel seal and back-up ring.
5. Fit the o-ring into its groove in the mounting flange and apply a small amount of Loctite® to the lower front face of the body.

6. Carefully fit the mounting plate in its original position. The drain hole in the rear face must be to the low pressure side, **DO NOT DAMAGE THE SEAL ON THE SHAFT.**
7. Fit washers and nuts to studs and torque to 65-70 lb-ft (88-95 Nm).
8. Pour a small amount of clean hydraulic fluid into the inlet port and check that the shaft can be turned without undue force.

f. Implement Pump Installation

1. Position pump in the mounting position.

Note: *Use new o-rings where required. Never reuse o-rings.*

2. Use the two Allen head bolts to secure the pump into place. Torque to 70 lb-ft (95 Nm).
3. Install the engine oil filter. Check engine oil level. Add oil as required.
4. Uncap and reconnect previously labeled hydraulic hoses to their proper locations.
5. Fill the hydraulic reservoir with clean, filtered hydraulic oil.
6. Prime the pump by filling the case drain port with fresh, filtered hydraulic oil from a clean container before installing the case drain connector and hose.
7. Check all routing of hoses and tubing for sharp bends or interference with any rotating members. All tube and hose clamps must be tight.
8. Install the belly pan.
9. Start the engine and run at approximately one-third to one-half throttle for about one minute without moving the machine or operating any hydraulic functions.
10. Inspect for leaks and check all fluid levels.

Note: *Check for leaks and repair as required before continuing.*

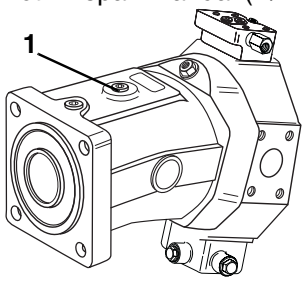
11. Close and secure the engine cover.

g. Pump Test

1. Perform a flow meter test on the pump.
2. Check the load sense.
3. Check the system functions.

8.9 FRONT DRIVE PUMP

For internal service instructions and detailed specifications, contact your local JLG distributor for a copy of the Rexroth Repair Manual (P/N 31200123).



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a. Front Drive Pump Removal

1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Drain the hydraulic reservoir or attach a vacuum adapter fitting to the reservoir fill tube to reduce oil spillage.
5. Label and disconnect all hydraulic hoses attached to the pump, cap all fittings and plug hoses to keep dirt & debris from entering hydraulic system.
6. Support the pump and remove the four bolts attaching the pump to the front axle.

b. Front Drive Pump Installation

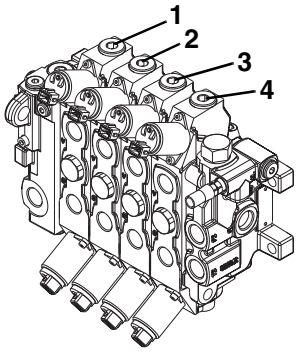
1. Install the pump onto the front axle. Torque the four bolts to 178 lb-ft (241 Nm). Use only new seals.
2. Uncap and reconnect the previously labeled hydraulic hoses to their appropriate locations.
3. Fill the pump with hydraulic fluid through the fill plug (**1**) before starting the machine.
4. Refill the hydraulic reservoir and inspect for leaks around the machine.
5. Close and secure the engine cover.

8.10 VALVES AND MANIFOLDS

8.10.1 Main Control Valve

The main control valve is mounted on the rear of the machine behind the rear access panel.

The main control valve assembly consists of various working sections with their own valve assemblies, each providing a specific hydraulic function. The section assemblies are the outlet, extend/retract (**1**), auxiliary (**2**), tilt (**3**), lift/lower (**4**) and load sense outlet sections.



a. Main Control Valve Removal

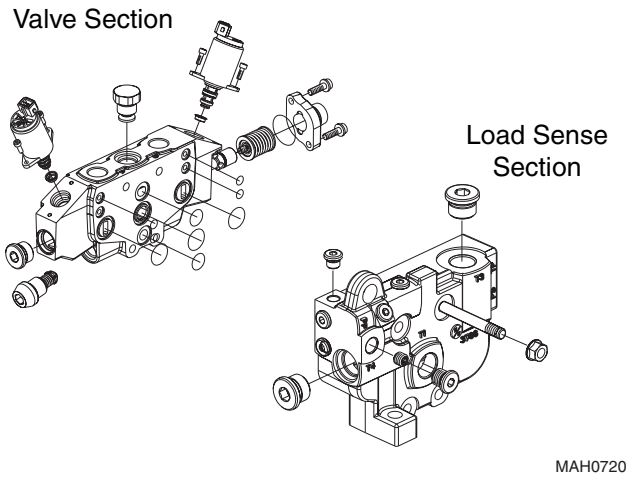
1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Remove the rear panel. Allow the hydraulic fluid to cool.
4. Thoroughly clean the main control valve and surrounding area, including all hoses and fittings, before proceeding.
5. Place a suitable container to catch hydraulic fluid drainage beneath the frame.
6. Label, disconnect and cap all the hydraulic hoses attached to the main control valve. Cap all fittings and openings to keep dirt & debris from entering the hydraulic system.
7. Wipe up any hydraulic fluid spillage in, on, near and around the machine and the work area.
8. Remove the four bolts securing the main control valve to the frame bracket.

b. Main Control Valve Disassembly

1. To disassemble the individual sections of the main control valve, remove the nuts from the end of the tie rod. Pull the tie rods out through the sections.
2. Disassemble each section assembly as required.

Some sections include a pre-adjusted relief valve that regulates pressure in a specific circuit.

***IMPORTANT: DO NOT** adjust any of the relief valve assemblies! Tampering with a relief valve will irrevocably alter pressure in the affected circuit, requiring recalibration or a new relief valve.*



Disassemble each Valve Section

1. Carefully separate the load sense outlet section from the crowd section.
2. Remove the o-rings from between the two sections.
3. Carefully separate each remaining section being careful not to lose the load sense shuttle ball.
4. Remove both end caps from each end of the valve sections then remove each control spool.
5. Remove any check valves, compensator valves, anti-cavitation valves or shock valves from each individual valve section if equipped.
6. Keep all parts being removed from individual valve sections tagged and kept together.

c. Main Control Valve Parts Cleaning

Clean all components with a suitable cleaner, such as trichlorethylene, before continuing. Blow dry.

d. Main Control Valve Parts Inspection

Inspect all parts and internal passageways for wear, damage, etc. If inner surfaces of any component **DO NOT** display an ultra-smooth, polished finish, or are damaged in any way, replace the damaged part. Often, dirty hydraulic fluid causes failure of internal seals, damage to the polished surfaces within the component, and wear of and/or harm to other parts.

e. Main Control Valve Assembly

Note: *ALWAYS replace seals, o-rings, gaskets, etc., with new parts to help ensure proper sealing and operation. Lubricate seals and o-rings with clean hydraulic oil.*

Assemble each Valve Section

1. Reassemble any check valves, compensator valves, anti-cavitation valves or shock valves from individual valve sections if equipped.
2. Install the control spool being careful not to nick or scratch the valve section bore or the control spool.
3. Install the end caps on each end of the valve section.

Assemble the Main Control Valve

1. Place all three tie rods with the washers and nuts through the end main control valve section.
2. Stand the end main control valve section on end.
3. Install proper o-rings and load sense shuttle on the inner face of the end main control valve section. Align the Crowd section over the three tie rods and slide onto the end main control valve section.
4. Using proper o-rings and load sense shuttle, repeat step three for the remaining sections.
5. Install the washers and nuts on the tie rods and torque to 18.5 lb-ft (25 Nm).

f. Main Control Valve Installation

1. Loosely install the four main control valve mounting bolts through bracket on the rear of the machine.
2. Install the main control valve onto the bracket, aligning the bolts with the holes in the end sections of the main control valve. Slide the main control valve into position, and tighten the bolts.
3. Prime the main control valve by filling the inlet openings with fresh, filtered hydraulic oil from a clean container, before attaching the hoses.
4. Use new oiled o-rings as required. Uncap and reattach and secure all hoses, clamps, etc. to the main control valve.
5. Check the routing of all hoses, wiring and tubing for sharp bends or interference with any rotating members, and install tie wraps and/or protective conduit as required. Tighten all tube and hose clamps.
6. Start the engine and run at approximately one-third to one-half throttle for about one minute without moving the machine or operating any hydraulic functions.
7. Inspect for leaks and check the level of the hydraulic fluid in the reservoir. Shut the engine OFF.
8. Wipe up any hydraulic fluid spillage in, on, near and around the machine, work area and tools.
9. Install the rear panel.

g. Main Control Valve Test

Conduct a pressure check of the hydraulic system in its entirety. Adjust pressure(s) as required. Refer to Section 8.5.2, “Main Control Valve Pressure Checking.”

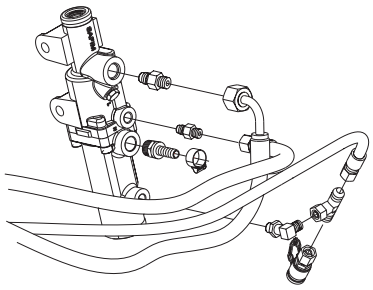
8.10.2 Service Brake Valve

The service brake valve is at the base of the steering column support, concealed by the lower dash cover.

The service brakes themselves are part of the front axle. Refer to Section 5, “Axles, Drive Shafts, Wheels and Tires,” for further information.

a. Service Brake Valve Removal

1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Remove the necessary dash panels.
5. Label, disconnect and cap the hydraulic hoses connected to the service brake valve. Cap all fittings and openings to keep dirt & debris from entering the hydraulic system.



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6. Remove the bolts that mount the service brake valve to the steering column support

Note: ***DO NOT*** *disassemble the service brake valve. The service brake valve is not serviceable and must be replaced in its entirety, if defective.*

b. Service Brake Valve Installation

1. Install the service brake valve to the steering column support with the necessary hardware.

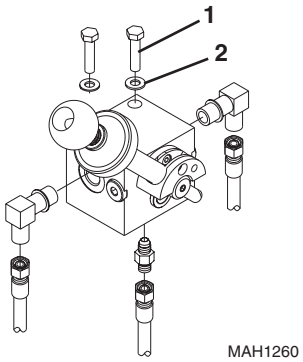
Note: *ALWAYS replace seals, o-rings, gaskets, etc., with new parts to help ensure proper sealing and operation. Lubricate seals and o-rings with clean hydraulic oil.*

2. Use new oiled o-rings as required. Uncap and reconnect the previously labeled hydraulic hoses to the appropriate locations.
3. Check the routing of all hoses, and tubing for sharp bends or interference with any rotating members, and install tie wraps and/or protective conduit as required. Tighten all tube and hose clamps
4. Start the engine and run at approximately one-third to one-half throttle for about one minute, without moving the machine or operating any hydraulic functions.
5. Inspect the service brake valve and connections for leaks, and check the levels of the hydraulic and brake fluid. Shut the engine OFF.
6. Replace the necessary dash panels.
7. Wipe up any hydraulic fluid spillage in, on, near and around the machine, work area and tools.
8. Close and secure the engine cover.

Note: *The service brake valve circuit will need to be bled after installation. Refer to Section 8.10.4, "Brake Test."*

8.10.3 Parking Brake

The park brake is secured with two capscrews (**1**) and lockwashers (**2**) at the left side of the seat base.



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a. Park Brake Removal

1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Loosen and remove the three bolts and washers holding the park brake valve cover. Remove the cover.
5. Label, disconnect and cap the hydraulic hoses on each side and bottom of the park brake valve. Disconnect and cap all hoses, fittings, etc.
6. Remove the two capscrews, and two lockwashers mounting the park brake valve to the left side of the seat base.

Note: ***DO NOT*** *disassemble the park brake valve. The park brake valve is not serviceable and must be replaced in its entirety, if defective.*

b. Park Brake Valve Installation

1. Install the park brake valve with the two lockwashers and two capscrews to mount the park brake valve to the left side of the seat base.

Note: *ALWAYS replace seals, o-rings, gaskets, etc., with new parts to help ensure proper sealing and operation. Lubricate seals and o-rings with clean hydraulic oil.*

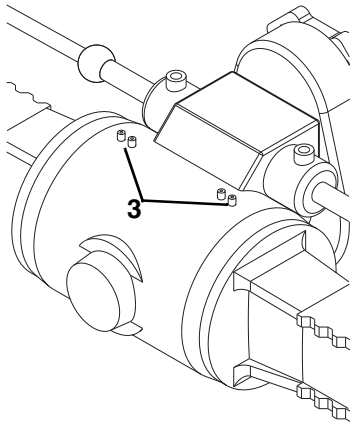
2. Use new oiled o-rings as required. Uncap, reattach and secure the three hoses.
3. Check the routing of all hoses for sharp bends or interference with any rotating members, and install tie wraps and/or protective conduit as required.
4. Start the engine and run at approximately one-third to one-half throttle for about one minute, without moving the machine or operating any hydraulic functions.
5. Inspect the park brake valve and connections for leaks, and check the level of the hydraulic fluid in the reservoir. Shut the engine OFF.
6. Replace the brake valve cover.
7. Wipe up any hydraulic fluid spillage in, on, near and around the machine, work area and tools.
8. Close and secure the engine cover.

Note: *The park brake valve circuit will need to be bled after installation. Refer to Section 8.10.4, "Brake Test."*

8.10.4 Brake Test

Carefully bleed the brake lines as soon as the brake valve is installed on the machine. Air in the system will not allow the brakes to apply properly. There are four brake bleeder locations (**3**) on the front axle. The outside bleeders are used for the park brake circuit. The inside bleeders are used for the service brake circuit. Work with an assistant to perform this procedure.

1. Place the transmission control lever in (N) NEUTRAL, engage the park brake, and start the engine.



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2. Remove the plastic cap from the brake bleeder. Attach one end of a length of transparent tubing over the brake bleeder. Place the other end of this tubing in a suitable transparent container that is partially filled with hydraulic oil. The end of the tubing must be below the oil level in the container.
3. **DO NOT** open the brake bleeder without holding the tubing firmly on the bleeder. There is pressure at the brakes. Carefully open the bleeder with a 12 mm wrench. Have an assistant depress the brake pedal. Close the brake bleeder when air bubbles no longer appear in the oil. Release the brake pedal. Remove the tubing from the brake bleeder.
4. Repeat steps 2 and 3 for the remaining brake bleeder.
5. If bleeding the service brake circuit, install a vacuum pump on the brake reservoir and remove the remainder of the trapped air from the brake system.
6. Check brake fluid level and add fluid if necessary. Refer to Section 2.4, "Fluids, Lubricants and Capacities."
7. Conduct a pressure and function check of the brake.

8.10.5 Steering Orbitrol Valve

Refer to Section 4.3.2, "Steering Column/Valve Replacement," for details.

8.10.6 Steer Select Valve

The steer select valve is attached to a manifold mounted on a mounting plate inside the frame near the front drive motor.

Verify the correct operation of the steer select valve solenoids before considering replacement of the valve. The housing of the steer select valve is not serviceable and must be replaced if defective.

a. Steer Select Manifold and Valve Removal

1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Label or otherwise mark the hydraulic hoses in relation to the steer select manifold. Disconnect and cap all hoses, fittings, solenoid wire terminal leads, etc.
5. Remove the capscrews that attach the manifold to the frame.

6. Remove the steer select manifold with attached steer select valve from the machine. Wipe up any hydraulic fluid spillage in, on, near and around the machine.

b. Steer Select Valve and Manifold Disassembly, Cleaning, Inspection and Assembly

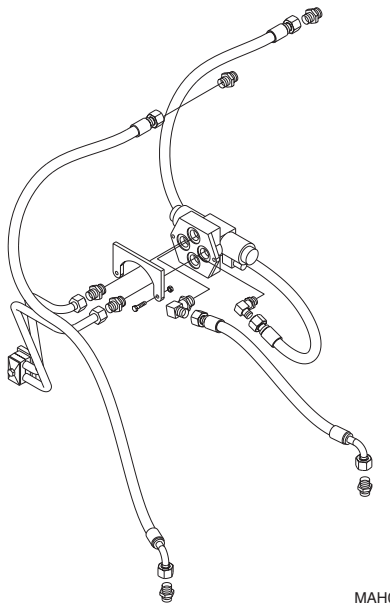
1. Place the steer select assembly on a suitable work surface.
2. Separate the steer select valve from the manifold by removing the capscrews. Discard the old o-rings.
3. Remove the solenoid valves and cartridges from the steer select housing.
4. Clean all components with a suitable cleaner before inspection.
5. Inspect the solenoid cartridges for proper operation. Check by shifting the spool to ensure that it is functioning properly. Check that the spring is intact. Inspect the cartridge interior for contamination.
6. Inspect internal passageways of the steer select manifold and valve for wear, damage, etc. If inner surfaces of the manifold **DO NOT** display an ultra-smooth, polished finish, or components are damaged in any way, replace the manifold or appropriate part. Often, dirty hydraulic fluid causes failure of internal seals and damage to the polished surfaces within the unit

Note: *ALWAYS replace seals, o-rings, gaskets, etc., with new parts to help ensure proper sealing and operation. Lubricate seals and o-rings with clean hydraulic oil.*

7. Install the solenoid valves and cartridges in the steer select housing.
8. Attach the steer select valve to the manifold using new, oiled o-rings and socket head capscrews.

c. Steer Select Manifold and Valve Installation

1. Attach the steer select manifold and valve to the mounting plate on the frame using the socket head capscrews.
2. Connect the hydraulic hoses, fittings, solenoid wire terminal leads, etc., to the steer select valve and manifold.
3. Check the routing of all hoses, wiring and tubing for sharp bends or interference with any rotating members, and install tie wraps and/or protective conduit as required. Tighten all tube and hose clamps.



4. Start the engine and run at approximately 1/3-1/2 throttle for about one minute, without moving the machine or operating any hydraulic functions.
5. Inspect for leaks and check the level of the hydraulic fluid in the reservoir. Shut the engine OFF.

Note: *Check for leaks and repair as required before continuing. Add hydraulic fluid to the reservoir as needed.*

6. Wipe up any hydraulic fluid spillage in, on, near and around the machine, work area and tools.
7. Close and secure the engine cover.

d. Steering Test

1. Conduct a pressure check of the steering hydraulic circuit at the test port on the implement pump. Refer to Section 8.5.5, “Steering Pressure Checking.”
2. Check each steering mode for proper function.

8.11 HYDRAULIC CYLINDERS

8.11.1 General Cylinder Removal Instructions

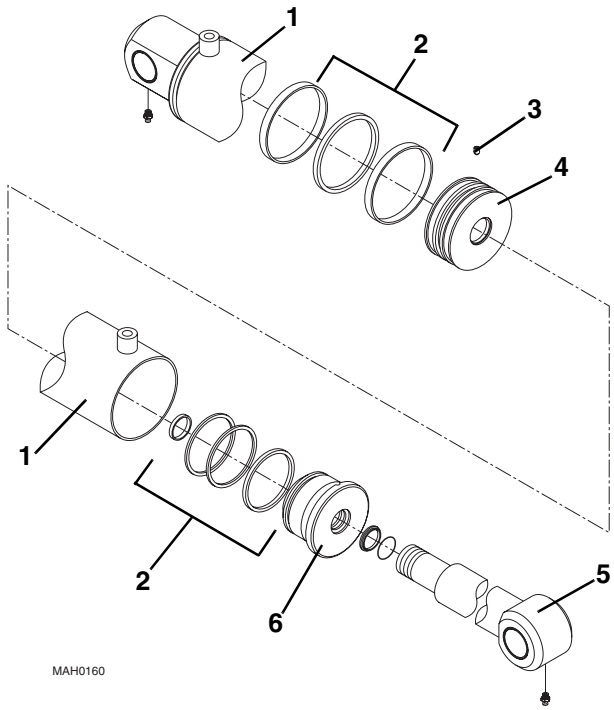
1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Chock the wheels.
3. Place an Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
4. Open the engine cover. Allow the system fluids to cool.
5. Label, disconnect and cap hydraulic hoses in relation to the cylinder.
6. Attach a suitable sling to an appropriate lifting device and to the cylinder. Make sure the device used can actually support the cylinder.
7. Remove the lock bolt and/or any retaining clips securing the cylinder pins. Remove the cylinder pins.
8. Remove the cylinder.
9. Wipe up any hydraulic fluid spillage in, on, near or around the machine.

8.11.2 General Cylinder Disassembly

1. Clean the cylinder with a suitable cleaner before disassembly. Remove all dirt, debris and grease from the cylinder.
2. Clamp the barrel end of the cylinder in a soft-jawed vise or other acceptable holding equipment if possible.

IMPORTANT: *Avoid using excessive force when clamping the cylinder in a vise. Apply only enough force to hold the cylinder securely. Excessive force can damage the cylinder tube.*

3. If applicable, remove the counterbalance valve from the side of the cylinder barrel.



IMPORTANT: *DO NOT tamper with or attempt to adjust the counterbalance valve cartridge. If adjustment is necessary, replace the counterbalance valve with a new part.*

4. Extend the rod (**5**) to allow access to the base of the cylinder.

IMPORTANT: *Protect the finish on the rod at all times. Damage to the surface of the rod can cause seal failure.*

5. Using a pin spanner wrench, unscrew the head gland (**6**) from the barrel (**1**). A considerable amount of force will be necessary to remove the head gland. Carefully slide the head gland down along the rod toward the rod eye end, away from the cylinder barrel.

IMPORTANT: *When sliding the rod and piston assembly out of the tube, prevent the threaded end of the tube from damaging the piston. Keep the rod centered within the tube to help prevent binding.*

6. Carefully pull the rod assembly along with the head gland out of the cylinder barrel.
7. Fasten the rod end in a soft-jawed vise, and put a padded support under and near the threaded end of the rod to help prevent damage to the rod.
8. Remove the set screw (**3**) from the piston (**4**).

Note: *It may be necessary to apply heat to break the bond of the sealant between the piston and the rod before the piston can be removed.*

Some cylinder parts are sealed with a special organic sealant and locking compound. Before attempting to disassemble these parts, remove any accessible seals from the area of the bonded parts. Wipe off any hydraulic oil, then heat the part(s) uniformly to break the bond. A temperature of 300-400° F (149-204° C) will destroy the bond. Avoid overheating, or the parts may become distorted or damaged. Apply sufficient torque for removal while the parts are still hot. The sealant often leaves a white, powdery residue on threads and other parts, which must be removed by brushing with a soft brass wire brush prior to reassembly.

9. Remove the piston head (**4**) from the rod (**5**) and carefully slide the head gland (**6**) off the end of the rod.
10. Remove all seals, back-up rings and o-rings (**2**) from the piston head and all seals, back-up rings and o-rings from the head gland.

Note: *The head gland bearing will need to be inspected to determine if replacement is necessary.*

DO NOT attempt to salvage cylinder seals, sealing rings or o-rings. ALWAYS use a new, complete seal kit when rebuilding hydraulic components. Consult the parts manual for ordering information.

8.11.3 Cylinder Cleaning Instructions

1. Discard all seals, back-up rings and o-rings. Replace with new items from complete seal kits to help ensure proper cylinder function.
2. Clean all metal parts with an approved cleaning solvent such as trichlorethylene. Carefully clean cavities, grooves, threads, etc.

Note: *If a white powdery residue is present on threads and parts, it can be removed. Clean the residue away with a soft brass wire brush prior to reassembly, and wipe with loctite® cleaner before reinstallation.*

8.11.4 Cylinder Inspection

1. Inspect internal surfaces and all parts for wear, damage, etc. If the inner surface of the tube does not display a smooth finish, or is scored or damaged in any way, replace the tube.
2. Remove light scratches on the piston, rod or inner surface of the tube with a 400-600 grit emery cloth. Use the emery cloth in a rotary motion to polish out and blend the scratch(es) into the surrounding surface.
3. Check the piston rod assembly for run-out. If the rod is bent, it must be replaced.

8.11.5 General Cylinder Assembly

1. Use the proper tools for specific installation tasks. Clean tools are required for assembly.
2. Install new seals, back-up rings and o-rings (**2**) on the piston (**4**) and the head gland (**6**).

Note: *The Crowd cylinder has a spacer that MUST be installed over the rod AFTER the head gland and BEFORE the piston head.*

3. Fasten the rod eye in a soft-jawed vise, and place a padded support under and near the threaded end of the rod (**5**) to prevent any damage to the rod.

IMPORTANT: *Protect the finish on the rod at all times. Damage to the surface of the rod can cause seal failure.*

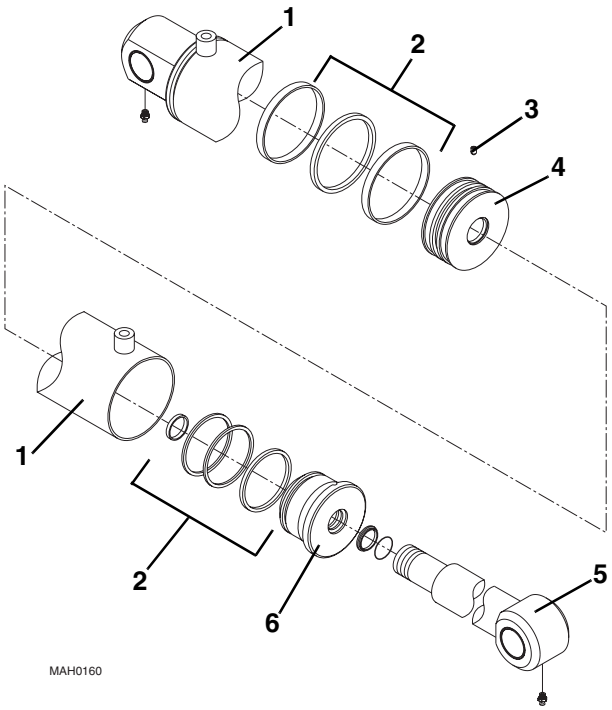
4. Lubricate and slide the head gland (**6**) over the cylinder rod (**5**). Install the piston head (**4**) on to the end of the cylinder rod. Loctite® and install the setscrew (**3**) in the piston head. Refer to Section 8.11.8, “Hydraulic Cylinder Torque Specifications,” for tightening guidelines for the piston head and the set screw.

IMPORTANT: *Avoid using excessive force when clamping the cylinder barrel in a vise. Apply only enough force to hold the cylinder barrel securely. Excessive force can damage the cylinder barrel.*

5. Place the cylinder barrel (**1**) in a soft-jawed vise or other acceptable holding equipment if possible.

IMPORTANT: *When sliding the rod and piston assembly into the cylinder barrel, prevent the threaded end of the cylinder barrel from damaging the piston head. Keep the cylinder rod centered within the barrel to prevent binding.*

6. Carefully insert the cylinder rod assembly into the tube.
7. Screw the head gland (**6**) into the cylinder barrel (**1**) and tighten with a spanner wrench. Refer to Section 8.11.8, “Hydraulic Cylinder Torque Specifications,” for tightening guidelines for the head gland.
8. If applicable, thread the new counterbalance valve into the block on the cylinder barrel.



8.11.6 General Cylinder Installation

1. Grease the bushings at the ends of the hydraulic cylinder. Using an appropriate sling, lift the cylinder into it's mounting position.
2. Align cylinder bushing and install pin, lock bolt or retaining clip.
3. Uncap and connect the hydraulic hoses in relation to the labels or markings made during removal.
4. Before starting the machine, check fluid level of the hydraulic fluid reservoir and if necessary, fill to full mark with Mobilfluid® 424 (ISO Grade 46) Tractor Fluid.
5. Start the machine and run at low idle for about one minute. Slowly activate hydraulic cylinder function in both directions allowing cylinder to fill with hydraulic oil.
6. Inspect for leaks and check level of hydraulic fluid in reservoir. Add hydraulic fluid if needed.
7. If no leaks are present, operate the hydraulic function at least twenty times at full throttle to bleed any air from the cylinder and hoses.

Note: *To bleed air from the tilt cylinder, operate the tilt function along with the lift cylinder as described above. More operation cycles may be required to clear all air from the system.*

8. Wipe up any hydraulic fluid spillage in, on, near and around the machine, work area and tools.
9. Close and secure the engine cover.

8.11.7 Steering Cylinders

The steering cylinders are attached to each axle center housing. The steer cylinders are covered in the appropriate Carraro axle literature.

8.11.8 Hydraulic Cylinder Torque Specifications

Description	G5-19A	G6-23A
All Cylinder Set Screws	15-18 lb-ft (20-25 Nm)	15-18 lb-ft (20-25 Nm)
Lift/Lower Cylinder		
Head Gland	369-406 lb-ft (500-550 Nm)	516-553 lb-ft (700-750 Nm)
Piston	1593-1630 lb-ft (2160-2210 Nm)	1940-1977 lb-ft (2630-2680 Nm)
Extend/Retract Cylinder		
Head Gland	221-258 lb-ft (300-350 Nm)	221-258 lb-ft (300-350 Nm)
Piston	406-443 lb-ft (550-600 Nm)	406-443 lb-ft (550-600 Nm)
Tilt Cylinder		
Head Gland	295-332 lb-ft (400-450 Nm)	516-553 lb-ft (700-750 Nm)
Piston	948-985 lb-ft (1285-1335 Nm)	1940-1977 lb-ft (2630-2680 Nm)
Compensating Cylinder		
Head Gland	295-332 lb-ft (400-450 Nm)	295-332 lb-ft (400-450 Nm)
Piston	822-859 lb-ft (1115-1165 Nm)	822-859 lb- ft (115-1165 Nm)

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Section 9
Electrical System

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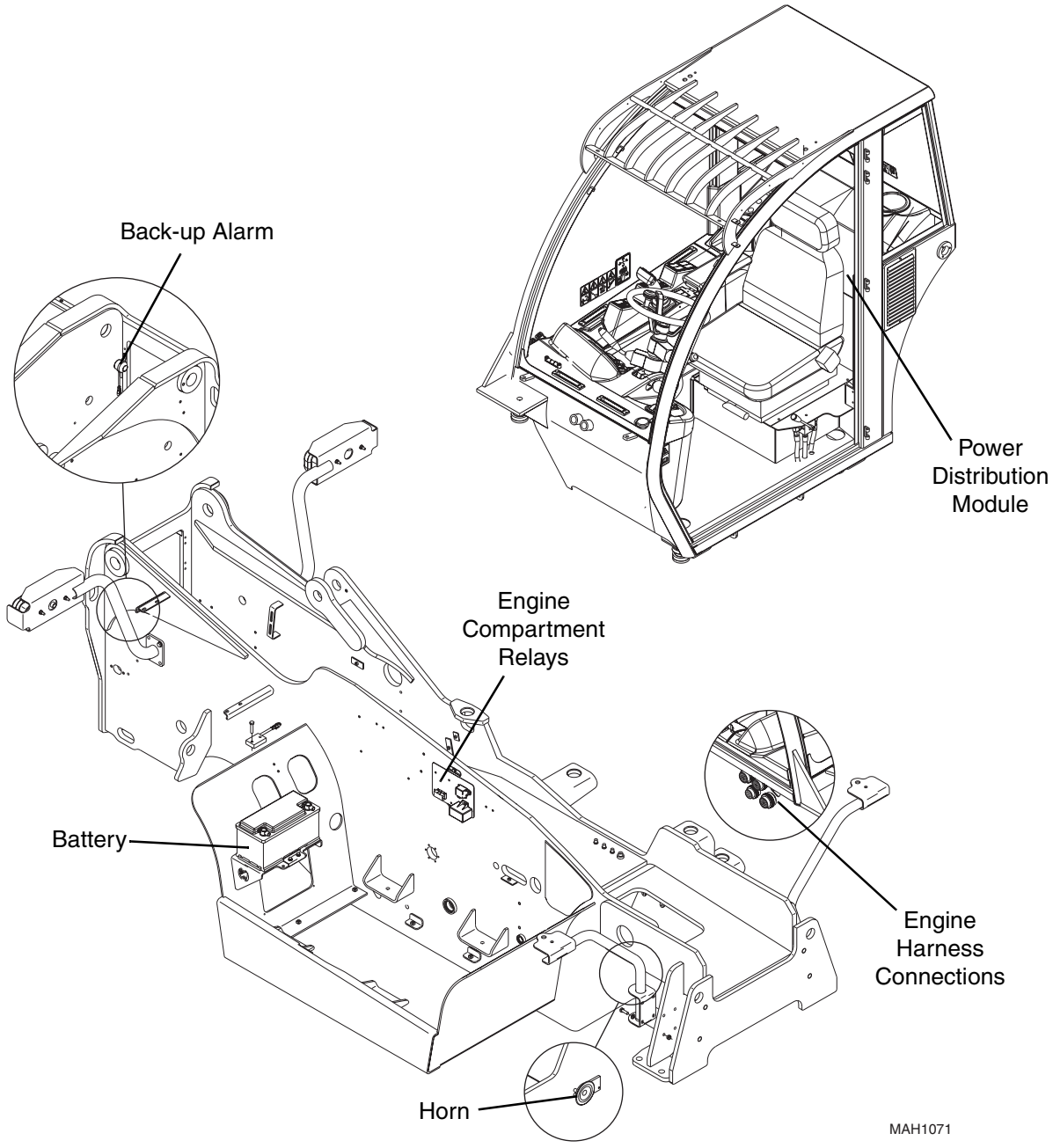
9.1 ELECTRICAL COMPONENT TERMINOLOGY

To understand the safety, operation, and service information presented in this section, it is necessary that the operator/mechanic be familiar with the name and location of the electrical components of the machine. The following illustration identifies the components that are referred to throughout this section.



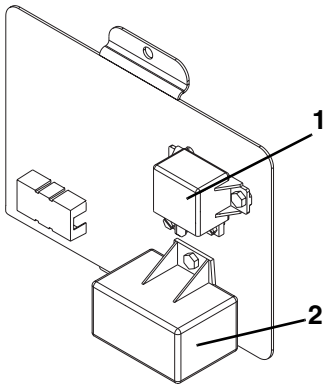
9.2 SPECIFICATIONS

Electrical system specifications are listed in Section 2, “General Information and Specifications.”

9.3 FUSES AND RELAYS

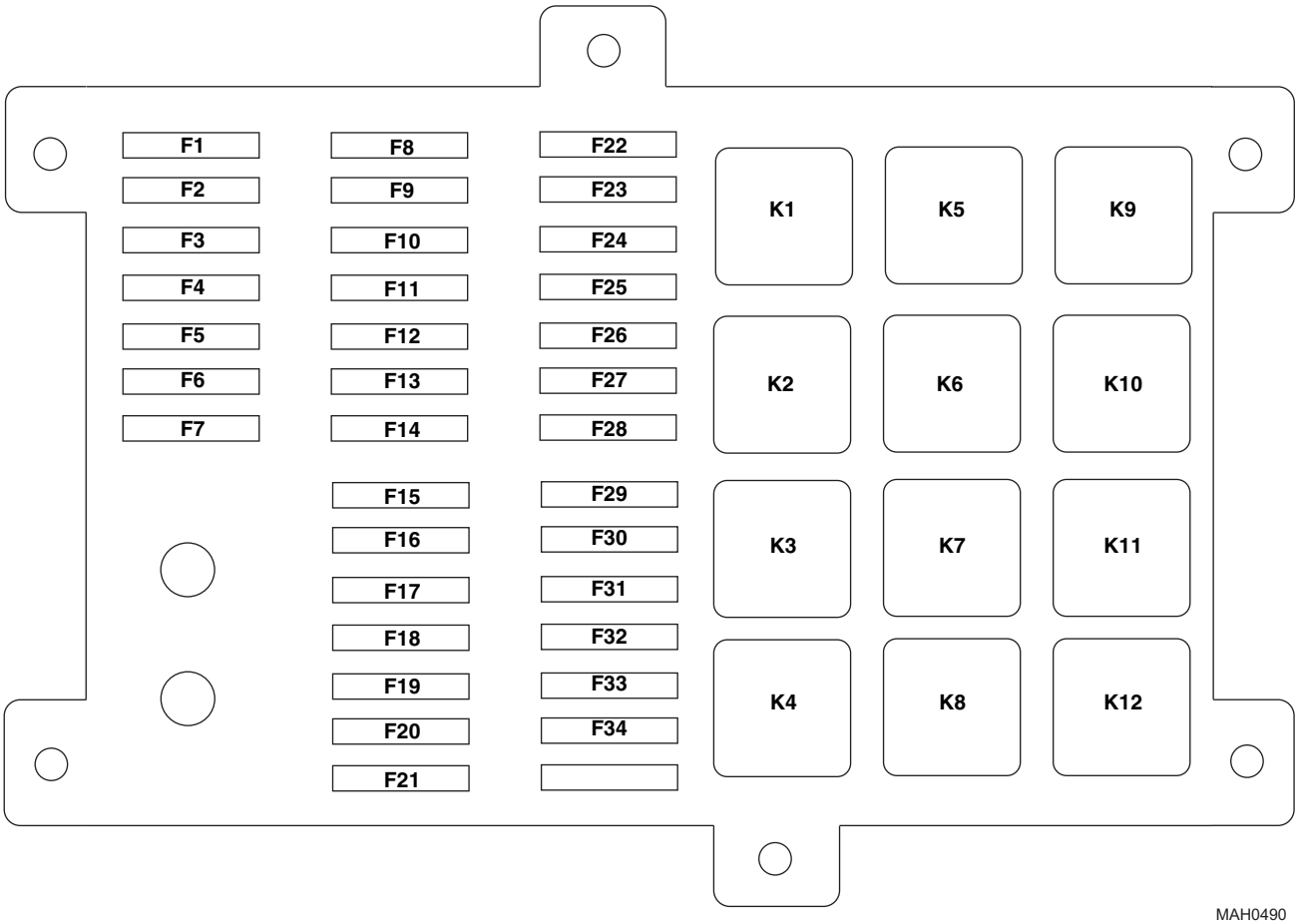
9.3.1 Engine Compartment Relays and Fuses

There are two relays and one buss bar located inside the engine compartment, mounted on a bracket behind the engine. The relays control the starter (**1**) and engine preheat (**2**).



MAH0480

9.3.2 Power Distribution Module



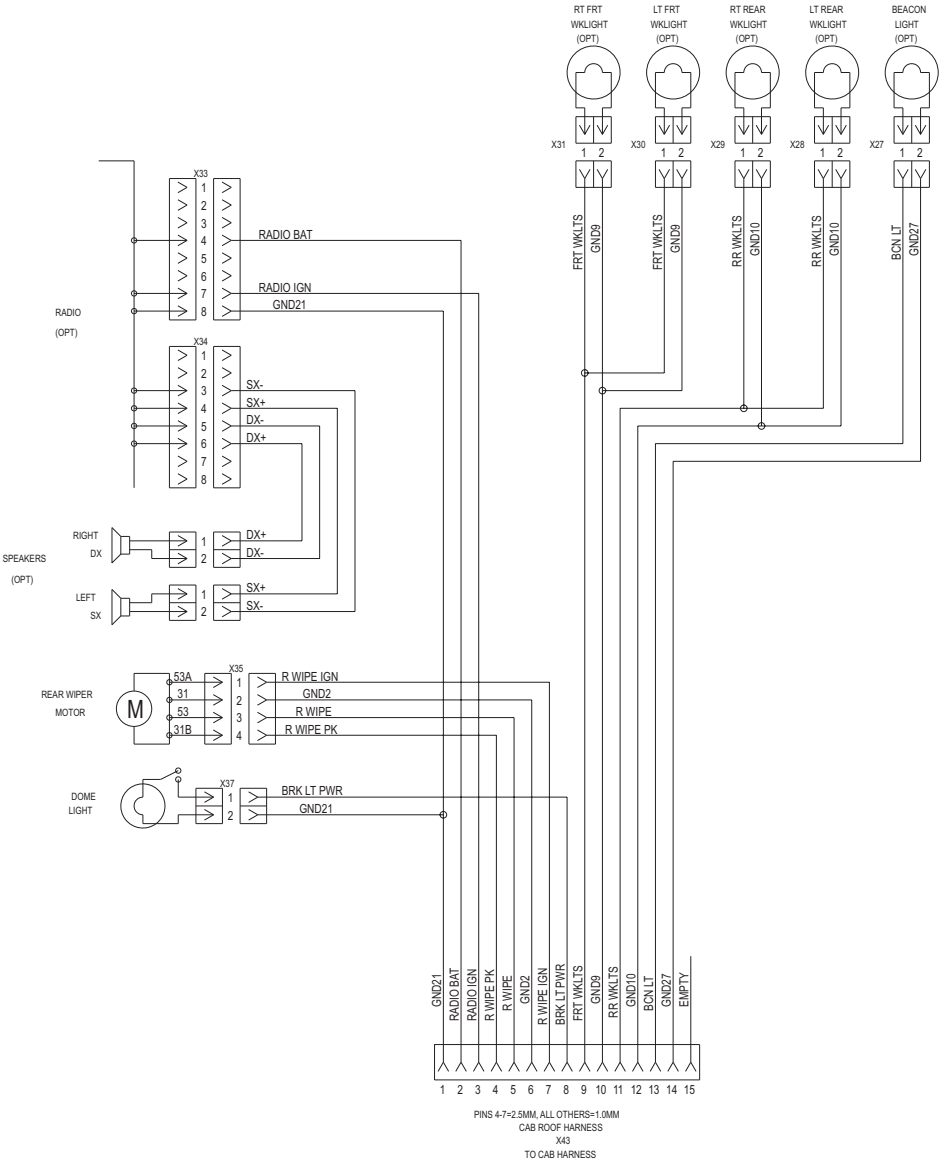
Fuse/Relay	Function	Amp Rating
F1	Right Headlight High	7.5
F2	Right Headlight Low	7.5
F3	Left Headlight High	7.5
F4	Left Headlight Low	7.5
F5	Radio	10
F6	Radio Bat	5
F7	Front Wiper	20
F8	Heater Fan	20
F9	Aux Pwr Socket	15
F10	Air Suspension Seat	10
F11	Ignition 1	10
F12	Left Park/Side Lights	7.5

F13	Right Park/Side Lights	7.5
F14	Front Worklights	15
F15	Rear Worklights	15
F16	Boom Lights	15
F17	Beacon/Aux	15
F18	Reserved Switch	15
F19	Reserved Bat	15
F20	Reserved Ignition	10
F21	PCB Bat	10
F22	Ignition 2	15
F23	LMI/Joystick	10
F24	PCB Ignition	15
F25	Rear Wiper	20
F26	Flasher Pwr	15
F27	Key Bat	15
F28	Brake Lights	15
F29	A/C Compressor	7.5
F30	Driving Lights Bat 1	20
F31	Driving Lights Bat 2	20
F32	Shift/Steer	15
F33	Engine Heater Control	7.5
F34	Fuel Solenoid/Cold Start	10
K1	Ignition Pwr 4	
K2	Reverse Travel	
K3	Start	
K4	Front Wiper	
K5	Flasher	
K6	Ignition Pwr 1	
K7	Ignition Pwr 2	
K8	Ignition Pwr 3	
K9	Work Lights	
K10	Boom Lights	
K11	Rear Wiper	
K12	Heater Fan	

9.4 ELECTRICAL SYSTEM SCHEMATICS

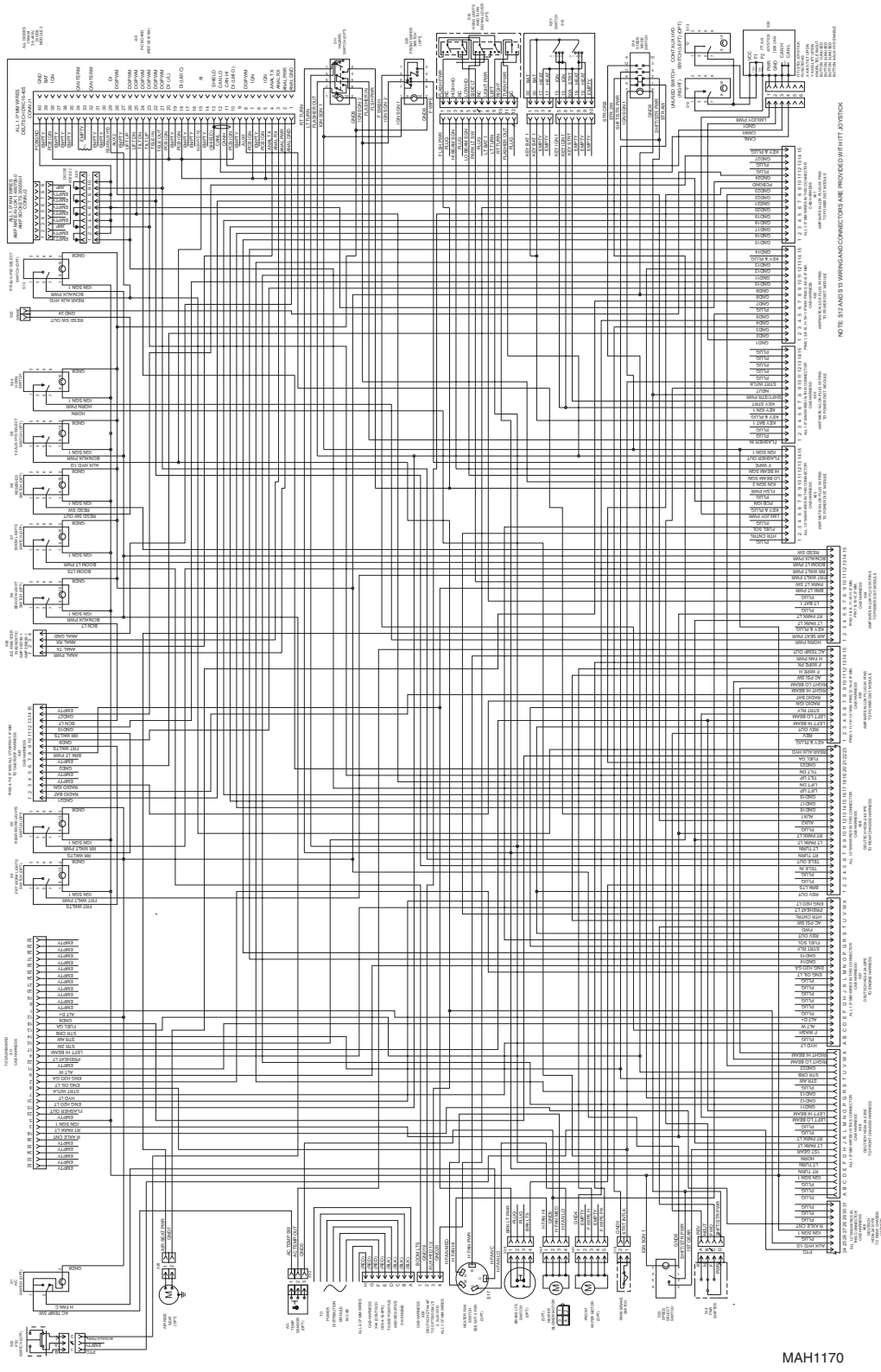
9.4.1 Cab Roof Schematic

Note: *For more detailed schematics, contact your local JLG distributor.*



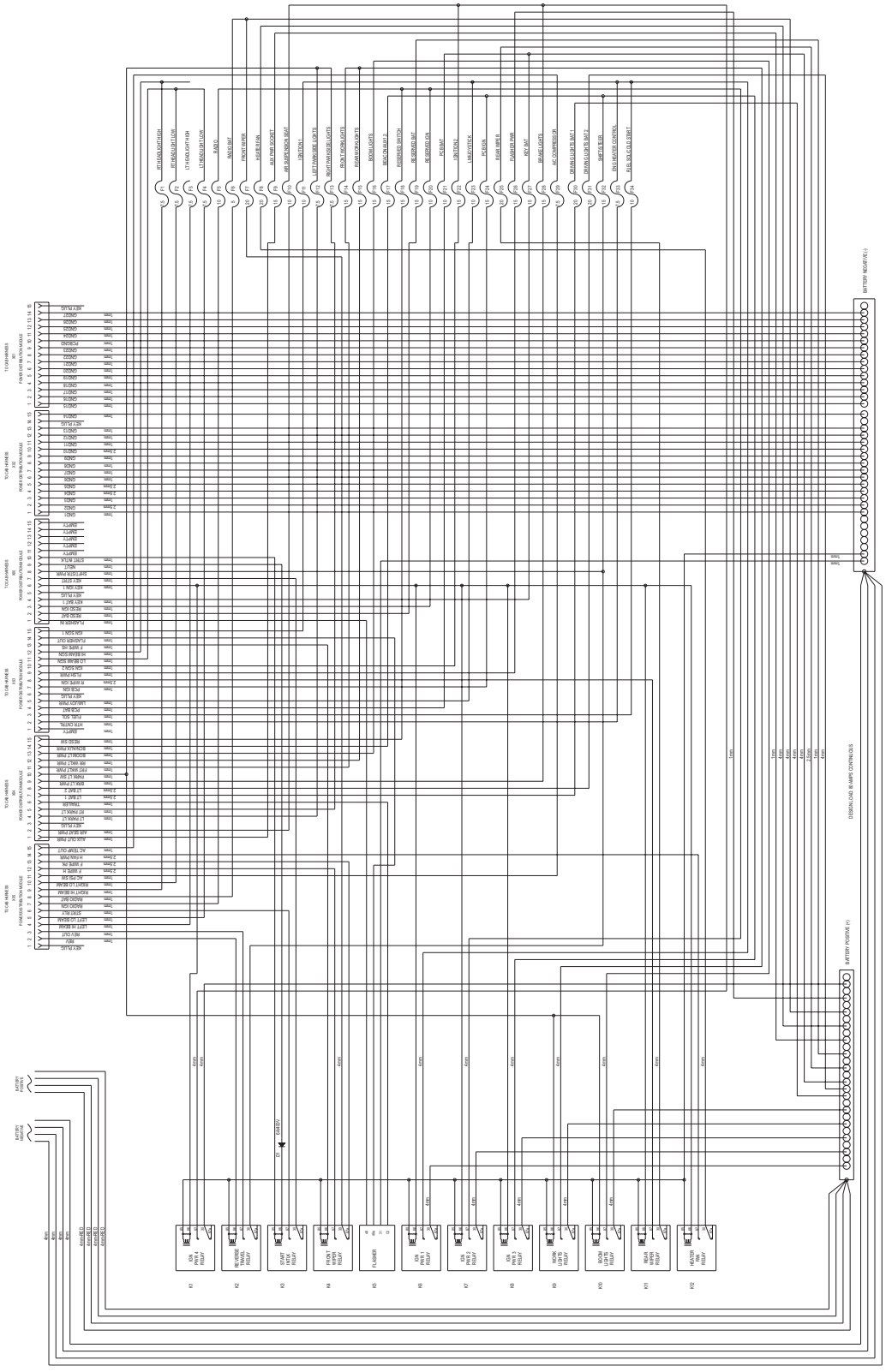
MAH0060

9.4.2 Cab Harness Schematic



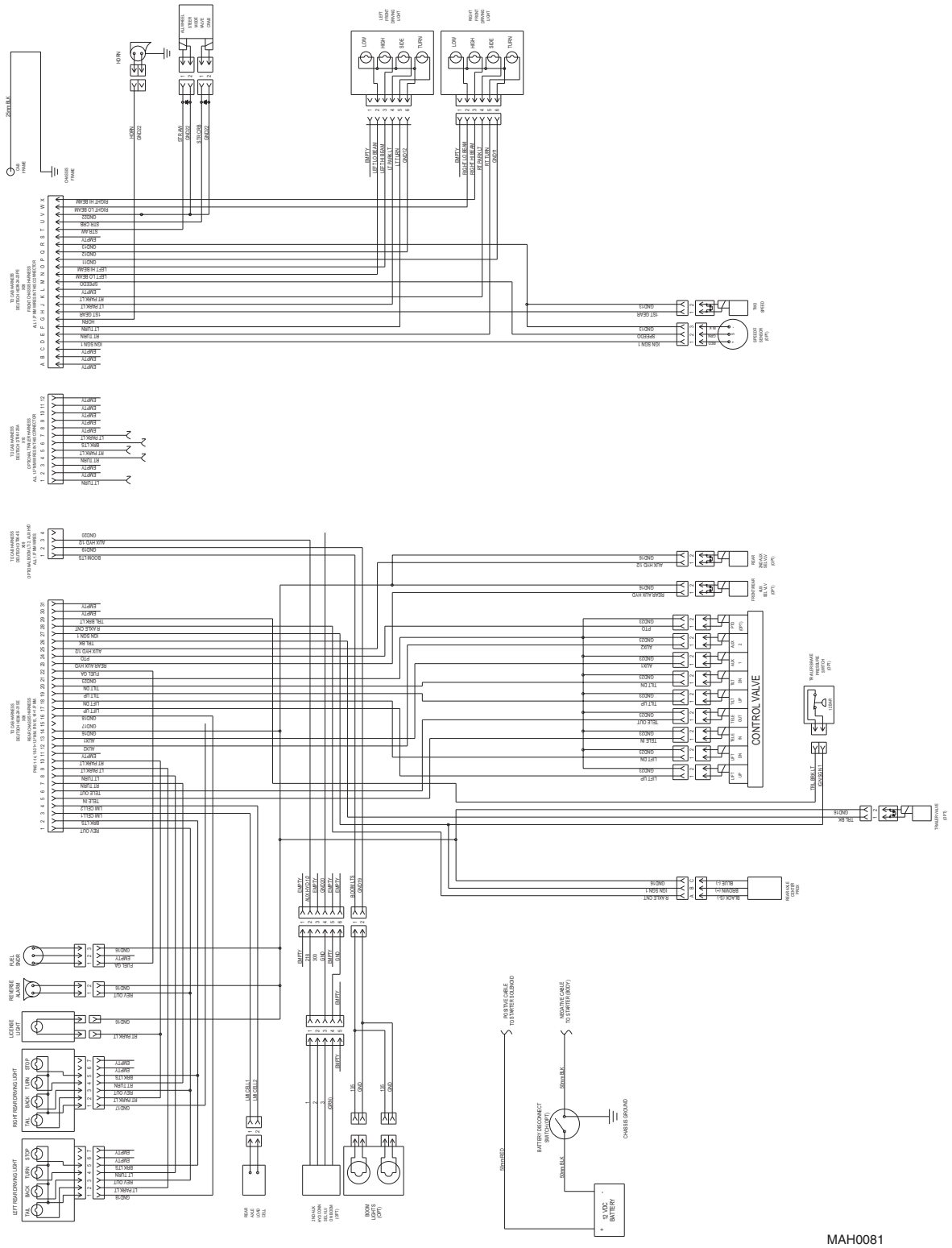
MAH1170

9.4.3 Power Distribution Module Schematic

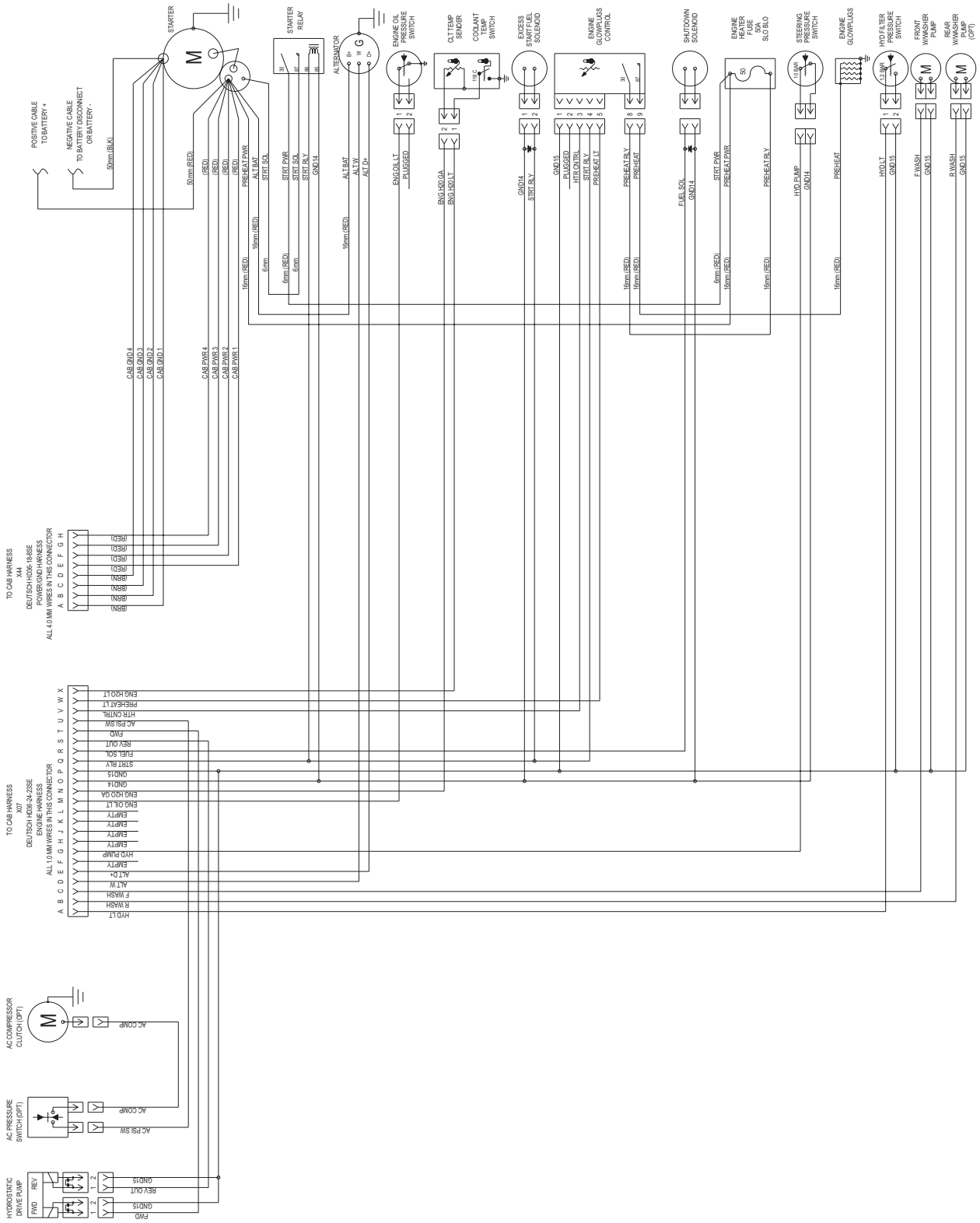


MAH0070

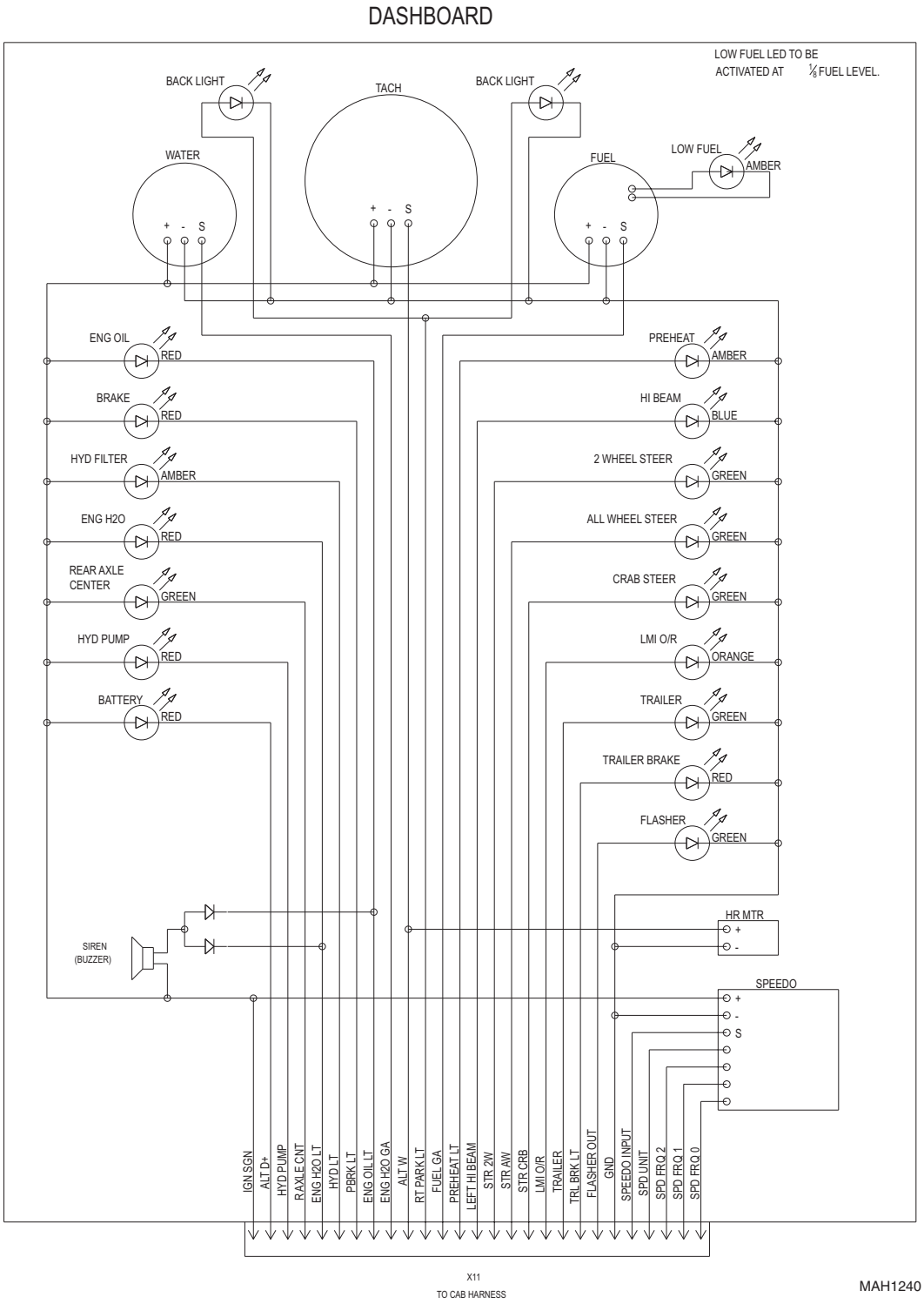
9.4.4 Front & Rear Chassis, Battery, Boom Harness Schematic



9.4.5 Engine Harness Schematic

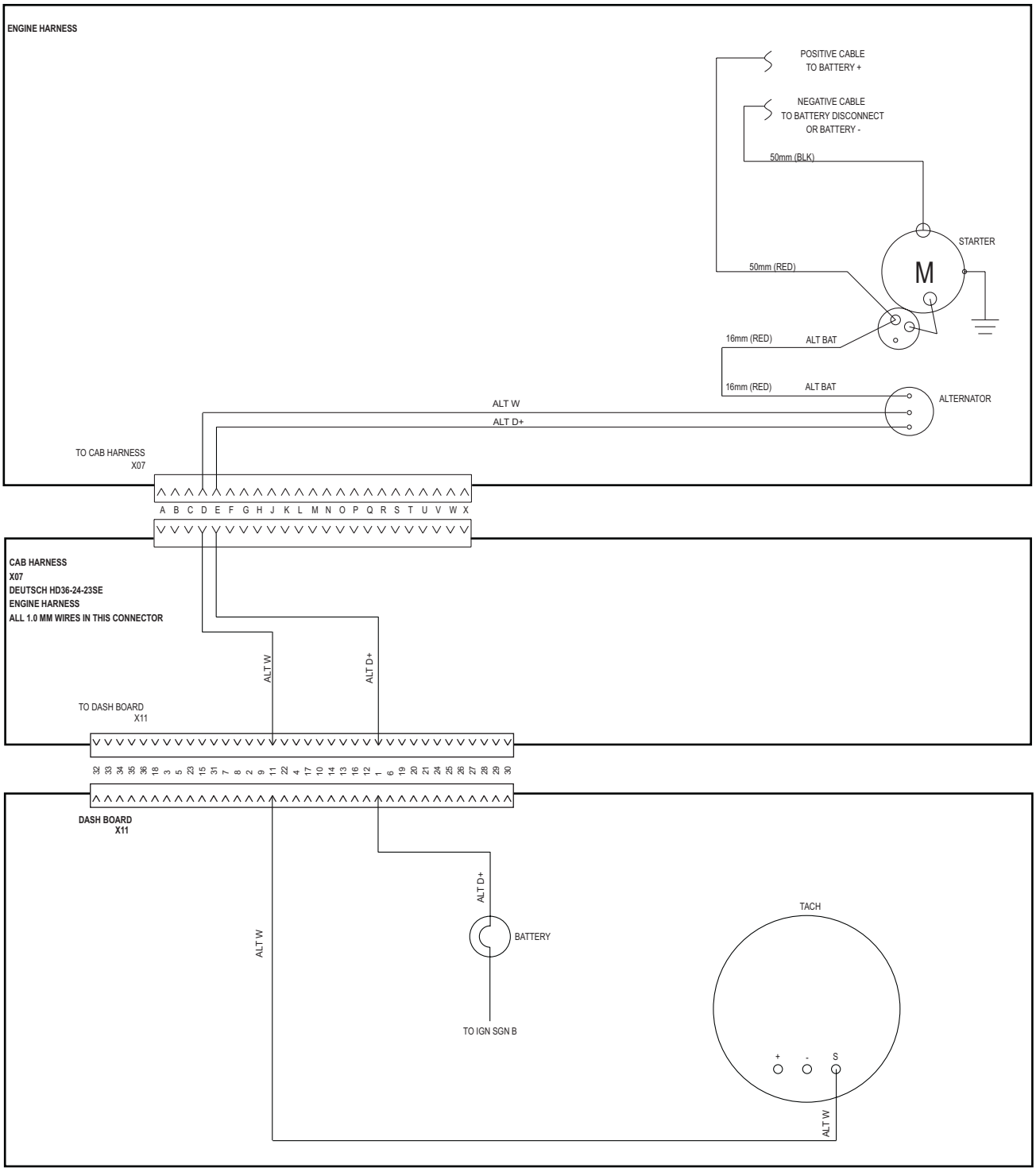


9.4.6 Dashboard Schematic



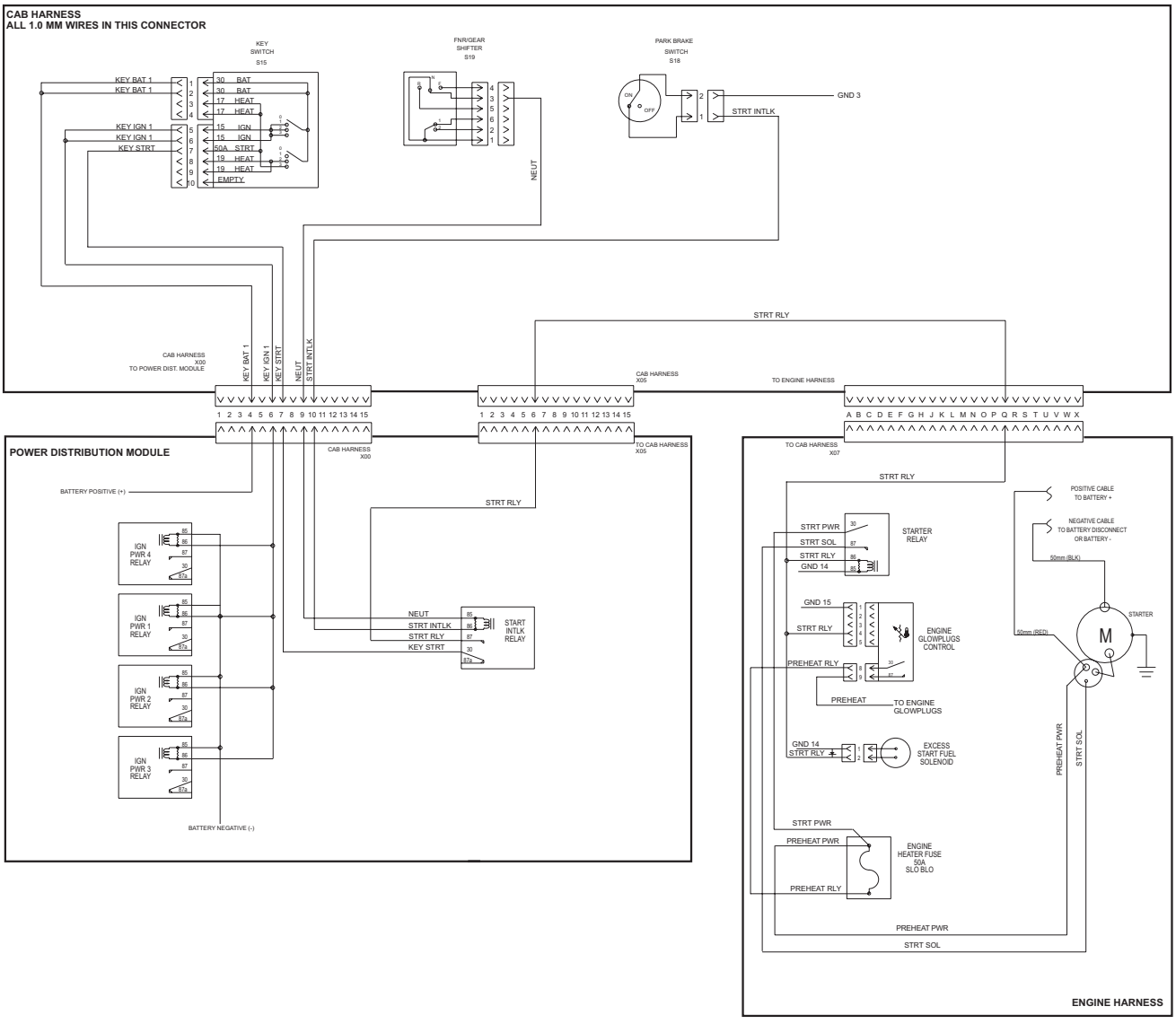
9.5 CIRCUIT BREAKDOWNS

9.5.1 Charge Circuit Breakdown



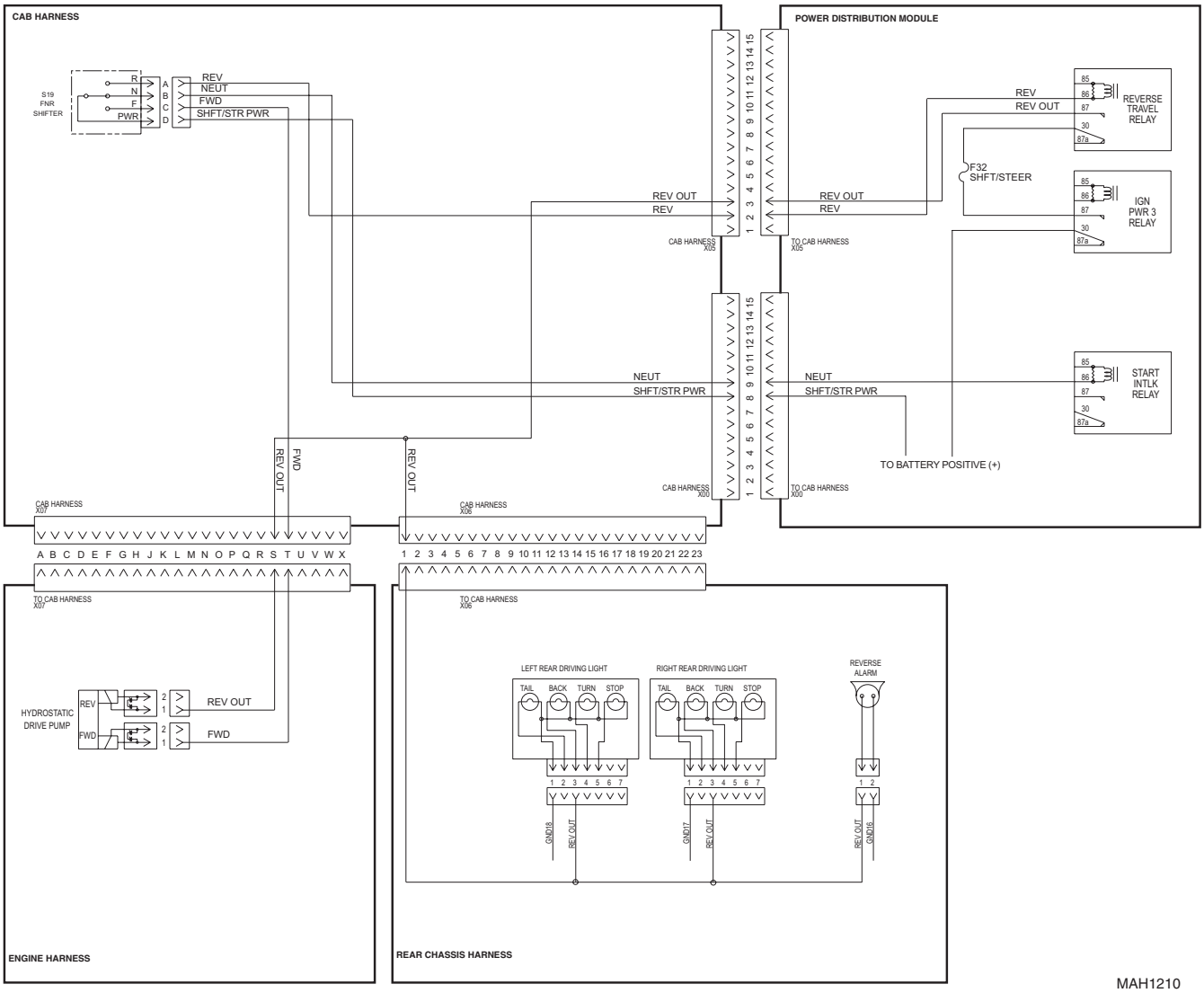
MAH1180

9.5.2 Start Circuit Breakdown



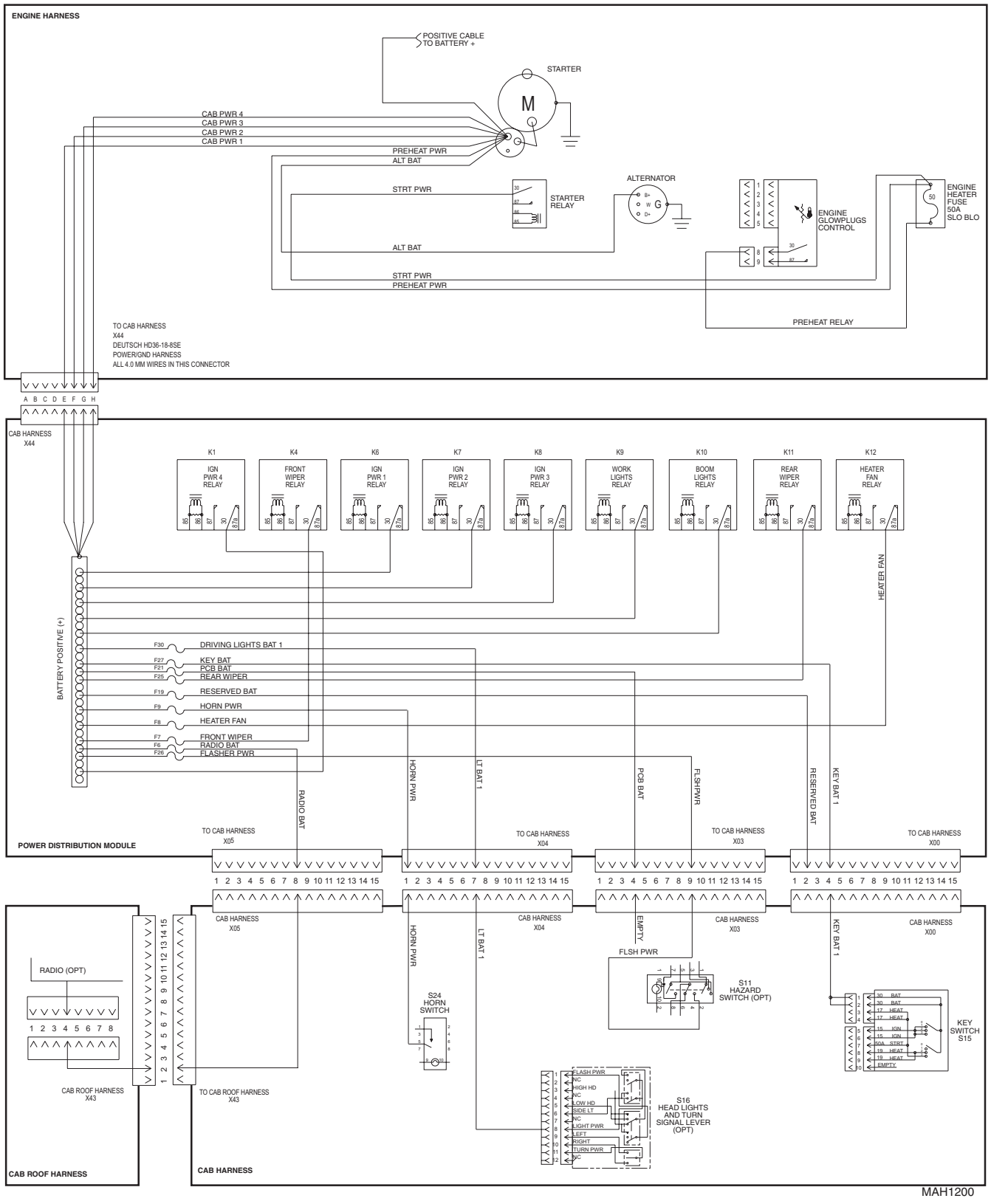
MAH0810

9.5.3 Drive Circuit Breakdown



MAH1210

9.5.4 Constant Power Circuit Breakdown

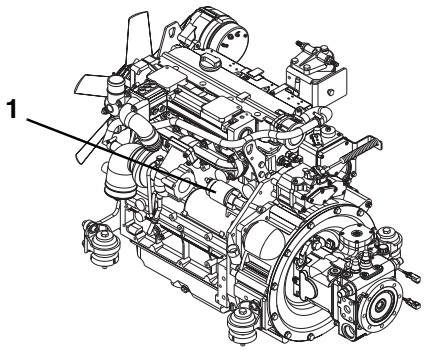


MAH1200

9.6 ENGINE START CIRCUIT

9.6.1 Starter

The starter (**1**) is located on the left side of the engine (the left side of the machine) underneath a heat shield attached to the flywheel.



MAH0210

a. Testing the Starter on the Engine

If the starter does not engage when the ignition key switch is turned, check the following:

1. The main fuse may be blown, requiring replacement. Check for the cause of the blown fuse.
2. There may be a defect in the ignition key switch, ignition wiring or starter solenoid.
3. Check battery condition. Clean the battery posts and the connectors at each end of the battery cables.
4. Check for broken wiring and damaged insulation on the wiring. Replace all broken or damaged wiring.
5. Check all connections at the starter solenoid, key switch and wiring harness plugs. Clean and tighten all connections.
6. If the starter still does not operate after these checks have been performed, check the starting circuit.

b. Starter Circuit Checks

1. Check wires and connections for looseness, corrosion, damage, etc.
2. If a “whirring” noise is heard but the engine does not turn over, the starter is spinning but not engaging the flywheel. The starter drive or solenoid that pushes the drive forward to engage the flywheel may be defective. Missing or damaged teeth on the flywheel can also prevent the starter from cranking the engine.
3. If the starter only “clicks” it may indicate that the battery is discharged, or that there is a loose or corroded battery cable connection. Check the battery state of charge and battery condition first, then check the cables and cable connections.
4. For additional information on the starting circuit, refer to Section 9.4.4, “Front & Rear Chassis, Battery, Boom Harness Schematic.”

c. Starter Removal

Remove the starter only if it fails. To remove the starter:

1. Open the engine cover.
2. Disconnect the battery negative (-) cable at the battery negative (-) terminal.
3. Remove the bolts that secure the starter heat shield. Disconnect the shield.
4. Remove the wires from the solenoid stud. Remove the red, positive (+) battery cable from the starter. Label and disconnect the wire from the starter solenoid housing stud. Record how the wires are installed to ensure correct installation later.
5. Loosen, but **DO NOT** remove, the fasteners securing the starter to the flywheel housing. Support the starter securely, as it is relatively heavy and will fall if not supported.
6. Support the starter and remove the fasteners securing the starter to the engine. Remove the negative (-) ground cable from its starter mounting bolt.
7. Remove the starter (**1**) from the machine.

d. Starter Cleaning and Drying

1. While the starter is being removed, wipe away any grease or dirt that has accumulated around the starter mounting opening.
2. If reinstalling the starter, clean the exterior of the starter with an approved solvent. **DO NOT** submerse the starter or allow the solvent to contact the starter bushings.
3. Dry the starter with a clean, lint-free cloth.

e. Starter Periodic Maintenance

A starter requires no routine maintenance beyond the occasional inspection of the electrical connections, which must be clean and tight.

***Note: DO NOT** disassemble the starter. The starter is not serviceable and must be replaced in its entirety, if defective.*

f. Starter Installation

1. Position the starter in its mounting opening on the flywheel housing. Position the ground cable over the correct starter mounting bolt. Secure the starter with fasteners. Torque fasteners to 32 lb-ft (43 Nm).
2. Connect the positive (+) battery cable to the upper solenoid stud. Install the wires to the upper solenoid stud, and secure with lockwasher and nut.
3. Connect the wire to the solenoid mounting stud.
4. Reattach the starter heat shield.
5. Connect the battery negative (-) cable to the battery negative (-) terminal.
6. Close and secure the engine cover.

9.7 CHARGING CIRCUIT

Before using a battery charger, an attempt can be made to recharge the battery by jump-starting the machine. (Refer to the appropriate Operation & Safety Manual.) Allow the engine to run, which will enable the alternator to charge the battery.

If the engine alternator charging warning indicator illuminates, perform the following checks:

1. Check the all battery cable connections at the battery, and verify that they are clean and tight.
2. Check the external alternator wiring and connections, and verify that they are in good condition.
3. Check the fan belt condition and tension.
4. Verify that the alternator mounting hardware is tight.
5. Run the engine and check the alternator for noise. A loose drive pulley, loose mounting hardware, worn or dirty internal alternator bearings, a defective stator or defective diodes can cause noise. Replace a worn or defective alternator.

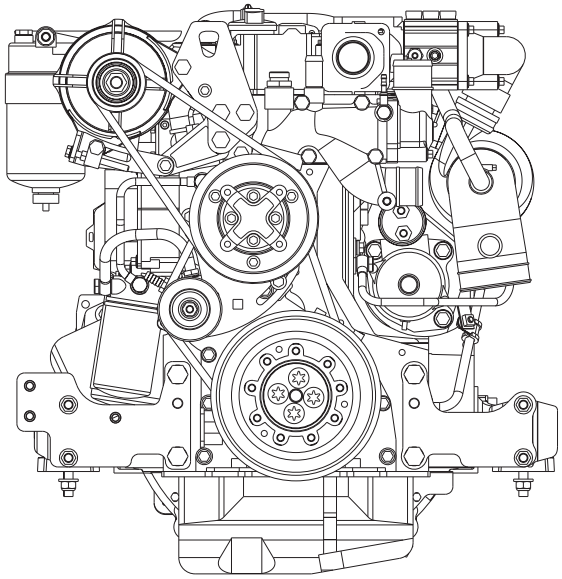
9.7.1 Alternator

a. Alternator Removal

1. Open the engine cover.
2. Disconnect the positive (+) and negative (-) battery cables at the battery terminals.
3. Label and disconnect the wires attached to the alternator.

Note: *Record how the alternator is installed to ensure correct installation later.*

4. Loosen the top mounting bolt, but don't remove it at this time. This will allow the alternator to swivel during belt removal.



MAH0220

5. Loosen the belt tensioning adjustment bolt at the bottom of the alternator to loosen the fan drive belt.
6. Remove the fan drive belt from the alternator.
7. Remove the lower mounting capscrew securing the alternator to the lower mounting hole on the engine.
8. While supporting the alternator with one hand, remove the upper mounting hardware from the upper alternator mount. Remove the alternator from the machine.

b. Alternator Installation

1. Position the alternator and align with the upper alternator mount on the engine bracket. Insert the upper mounting hardware through the alternator mount. **DO NOT** tighten completely at this time.

2. Align the lower alternator mount hole with the lower mounting bracket on the engine, and insert the lower mounting capscrew. Be sure to leave enough room to attach the drive belt.
3. Attach the fan drive belt to the alternator.
4. Adjust the lower belt tensioning bolt to remove excessive slack from the drive belt. Check for proper fan belt deflection.
5. Reattach the previously labeled electrical wires to the alternator.
6. Connect the positive (+) and negative (-) battery cables to the battery terminals.
7. Close and secure the engine cover.

9.8 ELECTRICAL SYSTEM COMPONENTS

9.8.1 Back-up Alarm

The back-up alarm is located at the rear of the machine.

When the transmission shift control switch (transmission control lever) is shifted to the (R) REVERSE position, the back-up alarm will automatically sound.

Place the transmission control lever in (R) REVERSE to test the back-up alarm. The back-up alarm must not sound when the transmission control lever is in (N) NEUTRAL or (F) FORWARD. Also, with the ignition key switch in the RUN position, the back-up alarm will sound when the transmission control lever is shifted into the (R) REVERSE position.

a. Disassembly

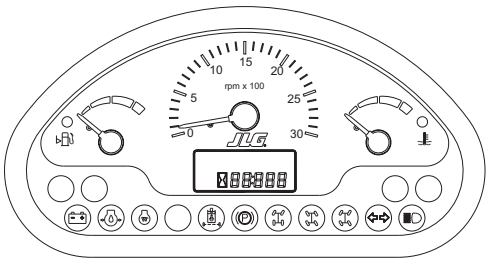
DO NOT disassemble the back-up alarm. Replace a defective or faulty alarm with a new part.

b. Inspection and Replacement

Inspect the wiring harness connector and alarm terminals for continuity and shorting. Test the alarm by turning the ignition key switch to the RUN position and shifting the transmission control lever into the REVERSE position. The alarm should sound.

Replace a defective or faulty alarm with a new part.

9.8.2 Instrument Cluster



MAH1090

a. Removal

CAUTION: Static electricity can cause damage to the operator's instrument cluster. Avoid any manner of touching (hands, tools, etc.) the printed circuit boards and terminals. Disconnect the battery negative (-) cable at its battery terminal before beginning this procedure. Failure to comply can result in damage to the operator's instrument cluster and malfunction of the instruments and indicator lights.

1. Open the engine cover.
2. Disconnect the battery negative (-) cable at the battery negative (-) terminal.
3. Remove the two nuts holding the instrument cluster to the dash.
4. Slide the instrument cluster out of the operator console.
5. Disconnect the wiring harnesses.

b. Installation

1. Connect the instrument cluster wiring harnesses.
2. Position the instrument cluster in the operator console.
3. Secure to the dash with two nuts.
4. Connect the battery negative (-) cable at the battery negative (-) terminal.
5. Close and secure the engine cover.

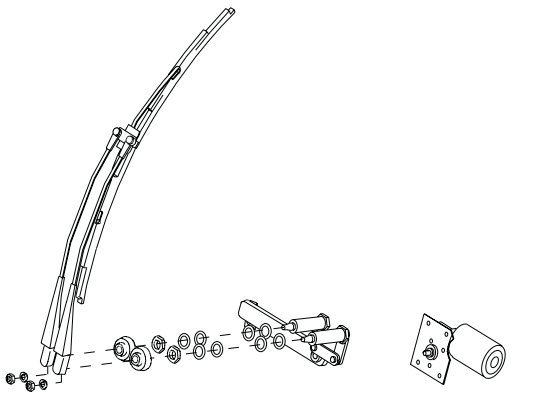
9.9 WINDOW WIPER/WASHER

9.9.1 Windshield Wiper Motor

a. Removal

Note: *It may be necessary to remove several hydraulic hoses from under the dash in order to remove and install the wiper motor housing.*

1. Open the engine cover.
2. Disconnect the battery negative (-) cable at the battery negative (-) terminal.
3. Remove the lower access panel below the instrument panel.
4. Disconnect the right side defroster hose from dash panel hose connector.
5. Disconnect the cab harness connectors from the wiper motor.



MAH0910

6. Remove the linkage attached to the wiper motor.
7. Loosen and remove the four bolts holding the wiper motor to the mounting bracket.

Note: *Retain all hardware removed from the wiper assembly for possible reuse on the replacement motor housing.*

8. Remove the motor from the inside of the cab.

b. Disassembly

DO NOT disassemble the motor. The motor is not serviceable. Replace motor if found to be defective.

c. Inspection and Replacement

Inspect the motor terminals for continuity. Replace motor if continuity is not found.

d. Installation and Testing

1. Install all required hardware to the motor assembly.
2. Align motor with the mounting holes and bolt the motor to the mounting bracket.
3. Connect the wiper linkage to the wiper motor shaft.

Note: *Align the wiper linkage arm with the flat on the motor shaft to ensure wiper stroke covers window area, and it does not swipe past the glass area.*

4. Connect the cab harness connectors to windshield wiper motor connectors.
5. Connect the negative (-) battery cable to the battery negative (-) terminal.
6. Close and secure the engine cover.
7. Turn ignition key switch to the RUN position, and operate windshield wiper in both LOW and HIGH speeds to ensure proper operation and that correct wiper travel is achieved.
8. Install right side defroster hose to the dash panel hose connector.
9. If previously removed, install hydraulic hoses under the dash.
10. Install the lower dash panel.
11. Close and secure the engine cover.

9.9.2 Windshield Washer Reservoir and Pump

The windshield washer motor and reservoir is located in the engine compartment as a unit and cannot be serviced separately.

a. Removal

1. Open the engine cover.
2. Disconnect the battery negative (-) cable at the battery negative (-) terminal.
3. Remove the nuts and the lockwashers from the washer mounting studs.
4. Pull the washer reservoir out and away from the mounting studs.
5. Rotate the washer reservoir, label and remove the cab harness connectors from the washer reservoir connectors.
6. Remove the windshield washer hoses from the reservoir.

b. Disassembly

DO NOT disassemble the pump. The pump is not serviceable. Replace pump if found to be defective.

c. Installation and Testing

1. Connect the windshield washer hoses to the reservoir.
2. Connect the cab wiring harness connectors to the reservoir connectors.
3. Install the reservoir tank onto the mounting studs.
4. Install the lockwashers and nuts and secure.
5. Fill the washer fluid reservoir with washer fluid.
6. Connect the battery negative (-) cable to the battery negative (-) terminal.
7. Close and secure the engine cover.
8. Turn the ignition key switch to the RUN position and press the washer switch. Verify that fluid is sprayed on the windshield.

9.10 CAB HEATER AND FAN

9.10.1 Cab Heater Controls

Note: *If the suspect component is found to be within the heater box, the heater box must be removed as a complete unit and replaced. For additional information on the removal and installation of the heater box, refer to Section 4.3.9, a. "Heater Assembly Removal."*

The cab heater controls are located to the right of the seat. The control panel consists of a variable speed fan control knob and a temperature control knob.

a. Cab Heater Controls Removal

Note: *After determining which control knob is not functioning, remove only the suspect control knob. In order to remove either knob, the cab heater and fan control panel must be removed from the dash panel.*

1. Open the engine cover.
2. Disconnect the battery negative (-) cable at the battery negative (-) terminal.
3. Remove the setscrew from the variable speed fan control knob or temperature control knob.
4. Remove the right side control panel screws.
5. Remove the screws and backing locknuts from the cab heater and fan control panel.
6. Pull the control panel out from the dash panel, and if removing variable speed fan control, remove the cab harness connector.
7. If removing the temperature control knob, disconnect the cable connector and remove control knob.
8. Remove the hex locknut from the suspect control shaft.
9. Remove the control from the panel.

b. Disassembly

DO NOT disassemble the cab heater and fan controls. The controls are not serviceable. Replace controls if found to be defective.

c. Installation and Testing

1. Check that the variable speed fan control is in the OFF position.
2. If installing the temperature control, attach the cable connector to the back of the control.
3. Insert the control shaft through the panel, ensuring that the knob is in the VERTICAL position.
4. Install the hex locknut on the shaft and tighten.
5. Connect the cab harness connector to the variable speed fan control.
6. Install the control panel screws.
7. Install the setscrew, securing the knob to the control.
8. Connect the battery negative (-) cable to the battery negative (-) terminal.
9. Close and secure the engine cover.

9.11 SWITCHES, SOLENOIDS AND SENDERS

9.11.1 Ignition Key Switch

a. Ignition Switch Removal

1. Open the engine cover. Allow the engine to cool.
2. Disconnect the battery negative (-) cable from the battery negative (-) terminal.
3. Remove lower dash panel.
4. Remove the hex nut securing the ignition key switch to the dash.
5. Reach up under the dash to work the ignition switch and wiring out of the mounting hole.
6. Disconnect the ignition switch connectors from the cab harness connectors, and remove the switch from the machine.

b. Disassembly

DO NOT disassemble the ignition switch. Replace a defective switch with a new part.

c. Inspection and Replacement

To determine the proper operation of the ignition key switch, using the following charts, test the wires on the back of the switch for continuity with an ohmmeter.

Test the ignition key switch for continuity, by checking from the ignition (#30) wires to each of the following wires in each switch position. Continuity (X) should be present as indicated in the following chart:

Switch Position			
Test from #30 wires to:	**OFF**	**RUN**	**START**
#50 Wire			X
#15 Wires		X	X

If all wires do not show proper continuity, replace the ignition switch.

d. Ignition Switch Installation

1. Connect the ignition key switch to the cab harness connectors.
2. Reach up and under the dash to work the ignition switch into the ignition switch-mounting hole on the lower right side of the dash.
3. Align the ignition switch so that when it is in the OFF position, the key slot is positioned vertically (straight up and down). Install the hex nut securing the ignition switch to the dash. **DO NOT** overtighten.
4. Install the lower dash panel.
5. Connect the battery negative (-) cable to the battery negative (-) terminal.
6. Close and secure the engine cover.

9.11.2 Dash Switches

a. Switch Removal

1. Open the engine cover. Allow the engine to cool.
2. Disconnect the battery negative (-) cable at the battery negative (-) terminal.
3. Pull the frame out of the dash, disconnect the harness connector to the switch in question and push the switch out of the frame.

b. Disassembly

DO NOT disassemble the dash switch. Replace a defective switch with a new part.

c. Inspection and Replacement

Inspect the switch terminals for continuity in both the engaged and disengaged positions. Replace a defective or faulty switch with a new switch.

d. Switch Installation

1. Connect the switch to the cab harness connector.
2. Position the switch over the rectangular switch bezel and snap into position.
3. Replace the frame into the dash.
4. Connect the battery negative (-) cable to the battery negative (-) terminal.
5. Start the machine and check the replaced switch for proper function.
6. Close and secure the engine cover.

9.11.3 Fuel Level Indicator and Fuel Level Sender

a. Fuel Level Indicator Testing

1. The fuel level sender wiring harness leads can be accessed from the top of the fuel tank. Disconnect the fuel level sender wiring harness leads. With the help of an assistant, touch both harness leads together.
2. From the operator's cab, have the assistant turn the ignition key switch to the RUN position. **DO NOT**

start the engine. Observe the fuel level indicator needle on the operator's instrument cluster.

3. Turn the ignition key switch to the OFF position. The fuel level indicator needle should return to the EMPTY position.

b. Fuel Level Circuit Tests

If the fuel level indicator is suspected of giving a false reading, perform the following checks:

1. If the fuel level indicator needle does not move, check the fuel tank for fuel.
2. Check for loose or defective wiring, faulty ground connections or corrosion on the fuel tank sender and wiring lead.
3. If the fuel level indicator needle does not move after the ignition key switch is turned to the RUN position, use a test lamp to determine whether current is flowing from the ignition switch to the fuel level sender.
4. If the fuel level indicator does not move and a faulty or defective fuel level sender in the fuel tank has been ruled out and in addition, wiring and connectors have been checked and ruled out, the fuel level indicator is defective and must be replaced.
5. Check that the ignition terminal has current and that the fuse in the fuse panel is not blown.
6. Check for broken, shorted, frayed, disconnected or damaged wiring between the fuel level indicator wiring at the cab, fuse and relay panel, ignition key switch and from the fuel level sender on the fuel tank through the wiring in the cab.
7. Check the fuel level sender. The resistance of the fuel level sender is 31 ohms for a full tank of fuel, 101 ohms for 1/2 tank and 255 ohms for an empty tank. A defective fuel level sender in the fuel tank may also prevent the fuel level indicator from moving.

9.11.4 Hourmeter

The hourmeter is a non-repairable instrument that records hours of machine engine operation in tenth of an hour increments and is located in the instrument cluster.

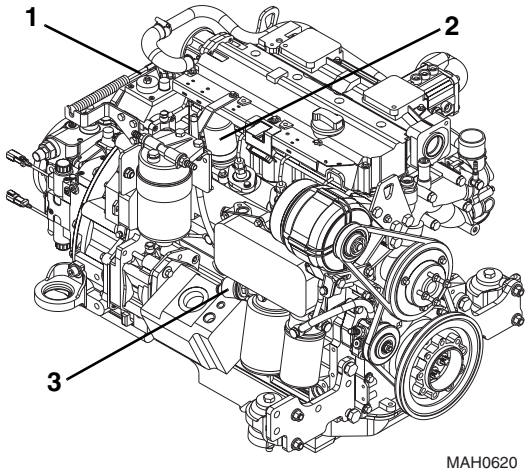
The hourmeter is an analog device, similar to an odometer, and will display 99,999.9 hours before resetting to zero.

If trouble is suspected, time the hourmeter for six minutes to verify that a tenth of an hour has been recorded.

The hourmeter is built into the instrument cluster and cannot be repaired. If the hourmeter is suspect, replace the instrument cluster.

9.11.5 Coolant Temperature Sender

The coolant temperature sender (**1**) is located on the back of the engine towards the rear of the machine.



a. Coolant Temperature Sender Removal

1. Open the engine cover. Allow the engine to cool.
2. Disconnect the battery negative (-) cable from the battery negative (-) terminal.
3. Disconnect the wiring connector at the coolant temperature sender lead.
4. The coolant temperature sender is threaded into the engine block. Remove the sender.

b. Coolant Temperature Sender Inspection and Replacement

Inspect the sender and the wiring harness connector terminals for continuity. Replace a defective or faulty sender with a new part.

c. Coolant Temperature Sender Installation and Testing

1. Thread the coolant temperature sender into the engine housing snugly, then connect the sender connector to the wiring harness connector.
2. Connect the battery negative (-) cable to the battery negative (-) terminal.
3. Check for proper fluid level.
4. Start the engine, allow it to reach operating temperature and observe the operator's instrument cluster for warning indication. If the sender is not defective, the problem could be elsewhere; possibly

in a shorted wire, improper-running engine, improper or low coolant, obstructed or faulty radiator, coolant pump, loose fan belt, defective instrument display, etc.

5. Close and secure the engine cover.

9.11.6 Fuel Shut-off Solenoid

The fuel shut-off solenoid (**2**) is located on the top of the engine near the fuel filter.

a. Fuel Shut-off Solenoid Removal

1. Open the engine cover. Allow engine to cool.
2. Disconnect the battery negative (-) cable at the battery negative (-) terminal.
3. Disconnect the wiring connector at the fuel shut-off solenoid lead.
4. Remove the fuel shut-off solenoid from the engine.

b. Fuel Shut-off Solenoid Disassembly

DO NOT disassemble a fuel shut-off solenoid. Replace a defective fuel shut-off solenoid with a new part.

c. Fuel Shut-off Solenoid Inspection and Replacement

Use a 12-volt DC source and ground to test the solenoid. Energize the solenoid, and watch for the plunger to retract. If the plunger does not retract, replace the fuel shut-off solenoid with a new solenoid.

d. Fuel Shut-off Solenoid Installation

1. Clean the exterior of the fuel shut-off solenoid engine location.
2. Install the fuel shut-off solenoid on the engine. **Do Not Over Tighten**.
3. Connect the wiring connector at the fuel shut-off solenoid lead.
4. Connect the battery negative (-) cable to the battery negative (-) terminal.
5. Start the engine. If the engine starts, the fuel shut-off solenoid is functioning. If the engine fails to start, the fuel shut-off solenoid may have a poor ground connection. Visually check the wiring at the fuel shut-off solenoid leads and/or check for continuity with a voltmeter as required.
6. Check for fuel and/or oil leakage around the solenoid.
7. Close and secure the engine cover.

9.11.7 Oil Pressure Sender

The oil pressure sender (**3**) is located on the engine near the oil filter.

a. Oil Pressure Sender Removal

1. Open the engine cover. Allow the engine to cool.
2. Disconnect the battery negative (-) cable from the battery negative (-) terminal.
3. Disconnect the wiring connector at the oil pressure sender lead.
4. The oil pressure sender is threaded into the engine. Remove the sender.

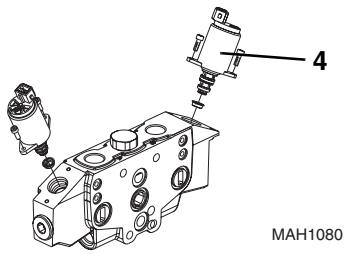
b. Oil Pressure Sender Inspection and Replacement

Inspect the sender and the wiring harness connector terminals for continuity. Replace a defective or faulty sender with a new part.

c. Oil Pressure Sender Installation and Testing

1. Thread the oil pressure sender into the engine housing snugly, then connect the sender connector to the wiring harness connector.
2. Connect the battery negative (-) cable to the battery negative (-) terminal.
3. Check for proper fluid level.
4. Start the engine, and observe the operator's display for warning indication. If the sender is not defective, the problem could be elsewhere; possibly in a shorted wire, improper-running engine, low oil, obstructed or faulty oil pump, defective instrument display.
5. Close and secure the engine cover.

9.11.8 Main Control Valve Solenoids



a. Main Control Valve Solenoid Removal

1. Open the engine cover. Allow the engine to cool.
2. Disconnect the battery negative (-) cable at the battery negative (-) terminal.
3. Remove rear panel
4. Disconnect the wiring connector at the valve solenoid lead.
5. Loosen and remove the two allenhead mounting screws.
6. Remove the valve solenoid (**4**) being careful not to lose or damage any o-rings. Note the location of any orifices, check valves and o-rings if equipped.

b. Main Control Valve Solenoid Disassembly

DO NOT disassemble a valve solenoid. Replace a defective valve solenoid with a new solenoid.

c. Main Control Valve Solenoid Installation

1. Install the valve solenoid using new o-rings and tighten the allenhead screws. **Do not over tighten.**
2. Connect the wire connector to the valve solenoid.
3. Start the machine and slowly move joystick to engage function. If further troubleshooting is required, refer to Section 9.4, “Electrical System Schematics.” or Section 8.6, “Hydraulic Schematic.”
4. Replace rear cover.
5. Close and secure the engine cover.

9.12 CONTROLLER

If the controller has been replaced, the default settings for the Joystick functions must be properly configured.

9.12.1 Joystick Functionality Setting

1. Connect the JLG Analyzer (P/N 2901443) tool to the PCB board on the machine. Turn the ignition to the ON position.
2. Scroll through the menus to find "ACCESS LEVEL 2"
3. Press enter and key in the code "38644" to enter "ACCESS LEVEL 0".
4. Scroll through the menus to find "MACHINE SETUP"
5. Choose the option that coincides with the joystick decal in the cab.

Code	Function
JYSTK ASSIGN: 1-X/K FORK/TELE	Joystick left/right = fork tilt Knurl = boom extend/retract
JYSTK ASSIGN: 2-X/KS TELE/FORK	Joystick left/right = boom extend/retract Knurl = fork tilt (slow)
JYSTK ASSIGN: 3-X/KF TELE/FORK	Joystick left/right = boom extend/retract Knurl = fork tilt (fast)

6. Verify that joystick functions coincide with the joystick decal in the cab.

9.13 TROUBLESHOOTING

9.13.1 Analyzer Usage

Help messages can be viewed using the JLG Analyzer (P/N 2901443). The Help messages can be accessed by pressing the ENTER key while viewing the current Help message. The Help message shall be EVERYTHING OK when no fault is present. The Analyzer cable plugs into the X26 connector of the PCB board located behind the operator’s seat.

When the analyzer is first connected, it defaults to access level 2. Settings may only be viewed in level 2. Settings cannot be changed until a password is entered to advance to one of three lower levels.

For more information, contact your local JLG distributor.

9.13.2 Fault Codes

The following Fault codes can be viewed with either the JLG Analyzer or by translating the flash codes on the PCB board. The LED on the PCB flashes out all fault codes from highest to lowest priority.

Help Message	Flash Code	Fault Condition	Action
SYSTEM VOLTS LOW	2-1	System voltage at pin J1-38<10 volts	If occurrence lasts for more than 3.2 seconds then disable all outputs. The fault shall be cleared upon all 3 axes of the joystick being set to neutral (X and Y and Knurl) and S4 and S1 and S2 becomes open.
SYSTEM VOLTS HIGH	2-2	System voltage at pin J1-38>15 volts	If occurrence lasts for more than 3.2 seconds then disable all outputs. The fault shall be cleared upon all 3 axes of the joystick being set to neutral (X and Y and Knurl) and S4 and S1 and S2 becomes open.
JOYSTICK FAULT	3-1	Joystick Fault	Disable all functions. The fault shall be latched and only reset upon power down of the controller.
SYSTEM LOCKED OUT CENTER JOYSTICK	3-2	Joystick X, Y, or Knurl axes not in neutral at system startup or S4 on the joystick closed	Disable all functions. The fault shall be cleared upon all 3 axes of the joystick being set to neutral (X and Y and Knurl) and S4 and S1 and S2 becomes open.
TELE OUT OPEN FAULT	4-1	Open on pin J1-21	None. Fault shall be latched and only reset upon power down of the controller.
TELE IN OPEN FAULT	4-2	Open on pin J1-22	None. Fault shall be latched and only reset upon power down of the controller.
TILT UP OPEN FAULT	4-3	Open on pin J1-23	None. Fault shall be latched and only reset upon power down of the controller.
TILT DOWN OPEN FAULT	4-4	Open on pin J1-24	None. Fault shall be latched and only reset upon power down of the controller.
LIFT DOWN OPEN FAULT	4-5	Open on pin J1-25	None. Fault shall be latched and only reset upon power down of the controller.
LIFT UP OPEN FAULT	4-6	Open on pin J1-26	None. Fault shall be latched and only reset upon power down of the controller.

Help Message	Flash Code	Fault Condition	Action
AUX HYD 1 OPEN FAULT	4-8	Open on pin J1-8	None. Fault shall be latched and only reset upon power down of the controller.
AUX HYD 2 OPEN FAULT	4-7	Open on pin J1-28	None. Fault shall be latched and only reset upon power down of the controller.
TELE OUT SHORT FAULT	5-1	Short to plus on pin J1-21	Disable Telescope Out output. Fault shall be latched and only reset upon power down of the controller.
TELE IN SHORT FAULT	5-2	Short to plus on pin J1-22	Disable Telescope In and Telescope Out outputs. Fault shall be latched and only reset upon power down of the controller.
TILT UP SHORT FAULT	5-3	Short to plus on pin J1-23	Disable Tilt Up and Tilt Down outputs. Fault shall be latched and only reset upon power down of the controller.
TILT DOWN SHORT FAULT	5-4	Short to plus on pin J1-24	Disable Tilt Down output. Fault shall be latched and only reset upon power down of the controller.
LIFT DOWN SHORT FAULT	5-5	Short to plus on pin J1-25	Disable Lift Down and Lift Up outputs. Fault shall be latched and only reset upon power down of the controller.
LIFT UP SHORT FAULT	5-6	Short to plus on pin J1-26	Disable Lift Up output. Fault shall be latched and only reset upon power down of the controller.
AUX HYD 1 SHORT FAULT	5-8	Short to plus on pin J1-8	Disable Aux Hyd 1 output. Fault shall be latched and only reset upon power down of the controller.
AUX HYD 2 SHORT FAULT	5-7	Short to plus on pin J1-28	Disable Aux Hyd 2 output. Fault shall be latched and only reset upon power down of the controller.
CAN COMMUNICATION	6-6	Open circuit, short to plus, or short to minus on pins J1-11 or J1-12	Disable all outputs. The fault shall be cleared upon all 3 axes of the joystick being set to neutral (X and Y and Knurl) and S4 and S1 and S2 becomes open.
EEPROM FAULT	9-9	eeprom	None. Fault shall be latched and only reset upon power down of the controller.

9.13.3 Analyzer Diagnostic Help Messages

The table below lists Diagnostic Help Messages that the Control System communicates to the Analyzer.

Diagnostics Submenu (Displayed on Analyzer 1st Line)	**Parameter** (Displayed on Analyzer 2nd Line)	**Parameter Value** (Displayed on Analyzer 2nd Line)	**Description**
GROUND INPUT:	JYSTK LOCK	ON/OFF	Display status of joystick lockout
	LMI CUTOUT	ON/OFF	Displays status of LMI Cutout
	LMI OVERRIDE	ON/OFF	Displays status of LMI Override
	AUX HYD	FRNT/REAR	Displays if front or rear auxiliary hydraulics is active
	AUX HYD	I/II	Displays if aux I or aux II outlet is active
GROUND OUTPUT:	TELE	IN/OUT XXX%	Displays telescope switch direction & demand.
	LIFT	UP/DOWN XXX%	Displays lift direction & demand
	FORK TILT	UP/DOWN XXX%	Displays fork lift direction & demand
	AUX HYD 1 OR 2	XXX%	Displays whether Auxiliary Hydraulics 1 or 2 is active and demand percentage.

Diagnostics Submenu (Displayed on Analyzer 1st Line)	**Parameter** (Displayed on Analyzer 2nd Line)	**Parameter Value** (Displayed on Analyzer 2nd Line)	**Description**
JOYSTICK:	X POSITION	±XXX%	Displays position in percentage for this axis
	X NEUTRL	IN NEUTRAL, NOT NEUTRAL, ERROR	Indicates whether joystick is in neutral position for this axis
	Y POSITION	±XXX%	Displays position in percentage for this axis
	Y NEUTRL	IN NEUTRAL, NOT NEUTRAL, ERROR	Indicates whether joystick is in neutral position for this axis
	AR	±XXX%	Displays position in percentage for the analog rocker
	AR NEUTRL	IN NEUTRAL, NOT NEUTRAL, ERROR	Indicates whether analog rocker is in neutral position
	S1	ON/OFF	Displays status of S1 pushbutton
	S2	ON/OFF	Displays status of S2 pushbutton
	S3	ON/OFF	Displays status of S3 pushbutton
	S4	ON/OFF	Displays status of S4 pushbutton
	F1	ON/OFF	Displays status of F1 pushbutton
SYSTEM:	GM BATTERY	XX.XV	Ground module battery voltage

Diagnostics Submenu (Displayed on Analyzer 1st Line)	**Parameter** (Displayed on Analyzer 2nd Line)	**Parameter Value** (Displayed on Analyzer 2nd Line)	**Description**
DATALOG:	ON	XXXXhXXm	Displays total controller on (power) time
	LIFT	XXXXhXXm	Displays total controller lift operation time
	FORK TILT	XXXXhXXm	Displays total controller fork tilt operation time
	TELE	XXXXhXXm	Displays total controller telescope operation time
	AUX HYD 1/2	XXXXhXXm	Displays total auxiliary hydraulics 1 and 2 operation time
	MAX VOLTS	XX.XV	Displays maximum measured battery voltage
	RENTAL	XXXXhXXm	Displays total controller operation time. NOTE: can be reset
	ERASE RENTAL?		Not available at password level 2. ENTER resets rental data log time to zero
VERSION:	GM SW	PX.X	Displays ground module software version
	GM HW REV	XXXX	Displays ground module hardware version
	GM SN	XXXXXX	Displays ground module serial number
	JYSTK SW	XX.X	Displays joystick software version
	ANALYZER	VX.XXXX	Displays Analyzer software version

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